MRT®
MOBILE RADIO TECHNOLOGY

Technical information for private, trunked and public safety networks.

APRIL 2000

ndardizing
iness radio
ɔels
kage delivery

nergizing public safety
se with mobile data

An INTERTEC®/PRIMEDIA Publication

Vertex--For Business, Industry, and Public Safety.

Vertex Radio Communications, the land mobile division of Yaesu, has been at the forefront of high-tech engineering and quality manufacturing for over 40 years. Always keeping customer satisfaction as their goal, the Vertex line meets the ever-growing demands of private sector, public safety, and governmental organizations.

The Vertex full line of wireless radio equipment is compatible with commercial specifications worldwide, and includes a wide variety of portable, compact/mobile base stations, HF/SSB transceivers, repeaters, and trunking systems.

Incorporating constant customer feedback with break-through design in synthesized radio communication technology has resulted in innovative products like the FTH-2070 32 Channel 5W Dual Band VHF/UHF Portable radio introduced in 1988. This unequaled radio gained immediate acceptance for its ability to link public safety organizations in time of crisis, and remains unique to Vertex today.

Now, with its expanded line--including the ultra-compact VX-10, 40 and 102 Channel VHF/UHF Portables -- Vertex Radio Communications provides solutions to communication needs for business, industry, and public safety.

For more information about the complete line of Vertex Radio Communications products, see your authorized Vertex dealer, or call:

562-404-2700

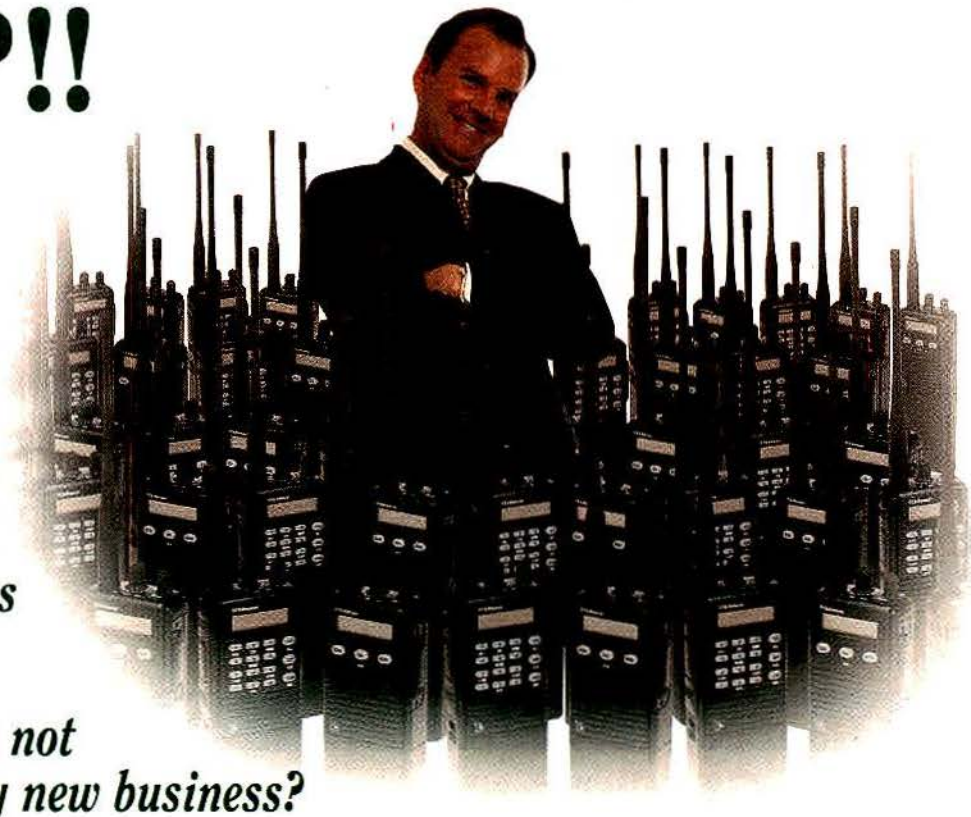
vertex
RADIO COMMUNICATIONS
Land Mobile Division of Yaesu U.S.A.

United States & Canada: Yaesu U.S.A., (562)404-2700

Circle (1) on Fast Fact Card

Visit us at IWCE Booth #1201.

HARVEST A CASH CROP!!



Trying to decide what to do with those frequencies you bought?

Current systems not winning you any new business?

The answer is LTR-Net™ from E.F. Johnson, the people who invented LTR® trunked radio. LTR-Net provides the seamless wide-area communications your customers are asking for, with infrastructure and subscriber radios that are truly affordable. LTR-Net also provides a wealth of features: roaming with auto-registration, electronic serial numbers, subscriber and group IDs, over-the-air system management, and system redundancy.

Most importantly, LTR-Net gives you the flexibility and LTR migration path you need to build the system that makes the most sense for your operation. Commercial users will benefit from the economy, features, and efficiency of networked dispatch radio. Cover your market with LTR-Net and win their business.

LTR-Net™

EFJohnson®

299 Johnson Ave., Waseca, Minnesota 56093
Fax 507-835-8356 • www.efjohnson.com

To find out more details, give us a call:

1-800-621-2945

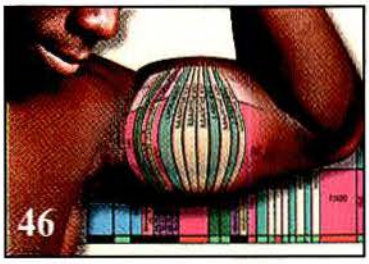
Visit us at IWCE, Booth #501.

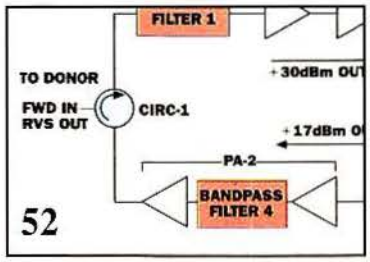
Circle (4) on Fast Fact Card

MRT
MOBILE RADIO TECHNOLOGY
April 2000

On the cover: Converting a worldwide organization's radio infrastructure to a standard format speeds delivery of services. See the story on page 28. *Cover design by Scott Dolash, art director. Photograph courtesy of UPS.*

FEATURES





DEPARTMENTS

Vol. 18, Issue 4. Mobile Radio Technology (ISSN 0745-7626) is published monthly by Intertec Publishing, 9800 Metcalf Ave., Overland Park, KS 66212-2215, and is mailed for free to qualified subscribers within the United States and Canada. Periodicals postage paid at Shawnee Mission, KS, and additional mailing offices. Canada Post Publications Mail (Canadian Distribution) Sales Agreement No. 0956309.
POSTMASTER: Send address changes to Mobile Radio Technology, P.O. Box 12960, Overland Park, KS 66282-2960.
SUBSCRIPTIONS: Non-qualified subscribers may subscribe at the following rates: United States and Canada: one-year: $35. Qualified and non-qualified subscribers in all other countries; one-year: $45 (surface mail); $105 (air mail). Subscription information: P.O. Box 12960, Overland Park, KS, 66282-2960.

NEW from TX RX

450-512 MHz

UHF Broadband Collinear Antennas

With two patents granted for this design, our omnidirectional collinear array antennas add a new dimension to conventional base station antenna coverage. The true corporate-feed design improves pattern control, allowing higher gain from a shorter antenna.

Model Number	Gain	Freq. Range	Bandwidth	Vertical Beamwidth	Power Handling	Connector
101-68-10-X-01N	10 dBd ±0.5 dB	450-512 MHz	62 MHz	10°	1000 watts	N female
101-68-10-X-01	10 dBd ±0.5 dB	450-512 MHz	62 MHz	10°	1000 watts	7/16 DIN

"X" = downtilt = 0, 3, 6 (degrees)

ONE MODEL COVERS ENTIRE 450-512 MHz BAND!

Come see us at IWCE, Booth #1022!

TX RX Systems Inc.
8625 Industrial Pkwy.
Angola, NY 14006
Ph: 716-549-4700
Fax: 716-549-4772
Email: sales@txrx.com
Web Site: www.txrx.com

TX RX SYSTEMS INC.

BIRD TECHNOLOGIES GROUP *A member of Bird Technologies Group*

Tx & Rx Multicouplers • Tower Mounted Preamplifiers • Signal Boosters • Duplexers • Cavity Filters • RF System Products

Circle (5) on Fast Fact Card

Scanning ...

Speaking to an audience at CTIA Wireless 2000 in New Orleans on Feb. 28, FCC Chairman William Kennard opined that the wireless industry's slogan ought to be "Wireless Is Not Less, It's More." Nah. Keep the day (and night) job, Mr. Chairman.

The head of the telecom agency was making his point that wireless is about to move from being a substitute for wired service to becoming a replacement for it, or a first choice.

Kennard observed, as we have done on this page and as others have, that the wireless industry is tagged by a name that defines it by what it is not.

"It needs a new name," he said, probably jesting.

Maybe it will get one. If it does, won't that toast the jelly of whoever casts the top bid in an auction to buy the "wireless.com" domain name?

According to domain name auctioneer Sitejockey.com, the "wireless.com" auction is over, negotiations are pending and "offers are still being accepted"—whatever that means. Maybe it means the top bidder is having trouble coming up with the cash. If that's so, the FCC chairman might be able to advise what to do.

"Wireless.com" is expected to sell for millions. "Business.com," for example, sold for $7.5 million last year to Santa Monica, CA-based eCompanies.

Small world: In a separate transaction, Marc Ostrofsky (who sold "business.com" —the name only, you understand— to eCompanies) sold two trade magazines and a trade show from his company, MultiMedia Publishing, to Intertec Publishing, which owns *Mobile Radio Technology*.

ComSpace in the house

Standing proud among CTIA exhibitors was two-way radio—uh, *private wireless*—system equipment manufacturer ComSpace. Why?

Word is that *eventually*, and eventually, may be a long time, but *eventually* ComSpace might like to see a handset manufacturer take an interest in making a dual-mode unit to combine 800MHz dispatch capability with wireless telephone, messaging and Internet access, ala Nextel. Together with ComSpace's capacity-boosting DC/MA technology, a combo handset could give SMR operators a product for competing with Nextel. The product would use the operator's own SMR channels for dispatch and "old" 800MHz cellular channels, or maybe "new" 700MHz third-generation (3G) cellular or PCS channels that might be developed following the 700MHz auction.

In this way, ComSpace could help SMRs to wedge themselves into the same business—uh, *space*—that Nextel now has to itself with combined cellular and dispatch.

ComSpace was there to get the word out about private wireless and its potential to offer a market for wireless handset technology.

Help from wideband I-access

Public safety agencies looking for ways to fund backbone telecommunications networks to link police, fire and ambulance stations may find friends among wideband wireless Internet access service providers.

Dave Dunford, our public safety consultant and columnist, tells us that the Lenexa, KS, police department let a supplier put a five-sector broadband antenna on its headquarters tower.

The system delivers Internet access to homes at a T1-plus rate. The equipment is cheap because of economies of scale, and service is cheap because it doesn't cost much to deploy in the industrial, scientific and medical (ISM) band.

The police department is providing space on the tower in exchange for the cash value of services to link fixed remote sites, not only fire stations, but also fixed command posts. Mobile data, video and intelligence information can be exchanged between computers quite readily. The cash value of the services provided to the department may amount to $200 to $400 per month per site.

Outsourcing wireless E9-1-1

At least one wireless E9-1-1 position-location system vendor at the CTIA show has hopped aboard the trend toward wireless carriers outsourcing almost everything except sales and customer service. For example, many carriers have sold their towers, and some appear ready to sell their entire technical infrastructure.

The Grayson Electronics division of Allen Telecom demonstrated its time difference of arrival (TDOA) technology as adapted for analog, TDMA and CDMA service, with GSM set to follow in April. What's different is that Grayson is prepared to design, install, operate, maintain and own the position-location system, acting as a service bureau for the carrier. It would handle all the transactions with the public safety answering point (PSAP). All Grayson needs is a connection to the base station antennas and a smidgeon of rack space.

What a (funny) business

Can't resist telling you what brought a gasp from the audience listening to the CTIA keynote session with Keiji Tachikawa, president of NTT Mobile Communications Network.

Tachikawa was explaining features offered by his network's proprietary Internet-like service when he said that, of its 1.2 million data customers, 1 million pay $1 per month to receive a new *cartoon* on their screens every day. He didn't say what he pays the cartoonist or what it costs for a few packets to transmit the cartoon to 1 million receivers, but how much could it be? Five thousand dollars? Twenty thousand dollars? That's $1 million per month of almost pure profit.

Chris Gent, chief executive of Vodafone AirTouch, followed Tachikawa for another segment of the session. In greeting the audience, he said he was pleased to be there and would spend the time necessary to cover his subject, but that afterwards he had an appointment with a cartoonist.

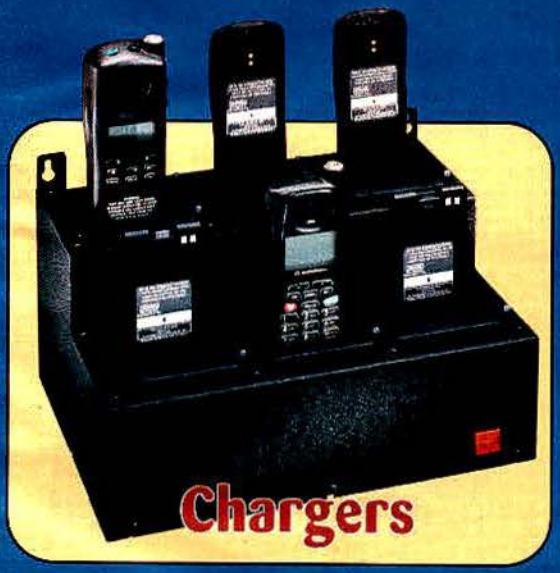
don_bishop@intertec.com

Don Bishop

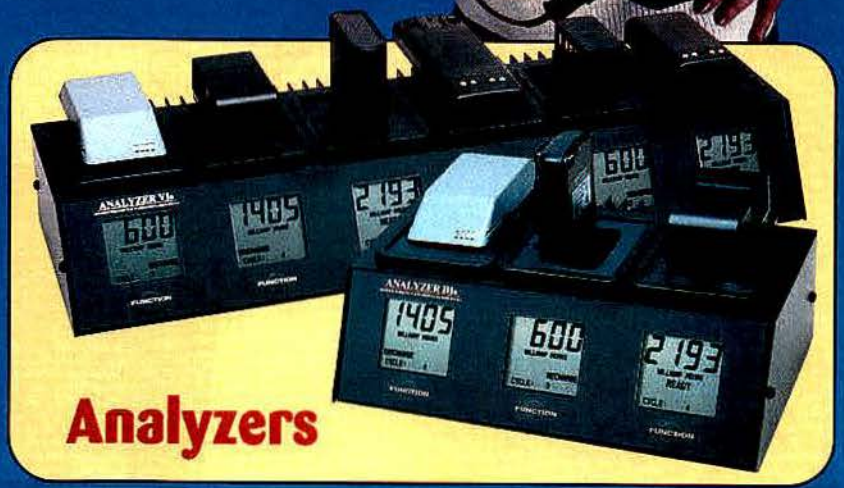
"FIRST TO MARKET"

With New Products...Always Ahead of The Competition!

Two-Way Replacement Batteries



Chargers



Analyzers

All Products Made in U.S.A.

With Over 20 Years of Manufacturing Experience

+W&W− WHERE QUALITY IS #1

Visit us at IWCE, Booth #225.

W&W Manufacturing Co.

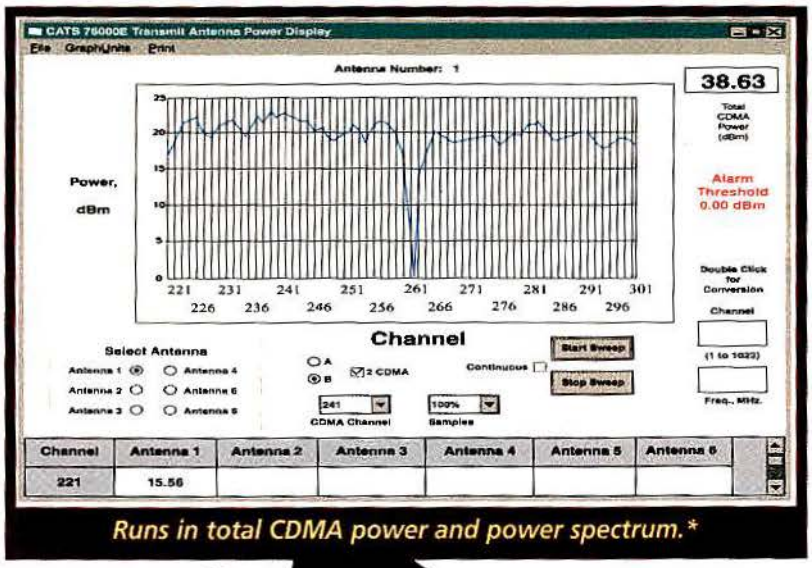
800 South Broadway, Hicksville, NY 11801

In U.S. & Canada 800-221-0732 • In NY 516-942-0011 Fax 516-942-1944

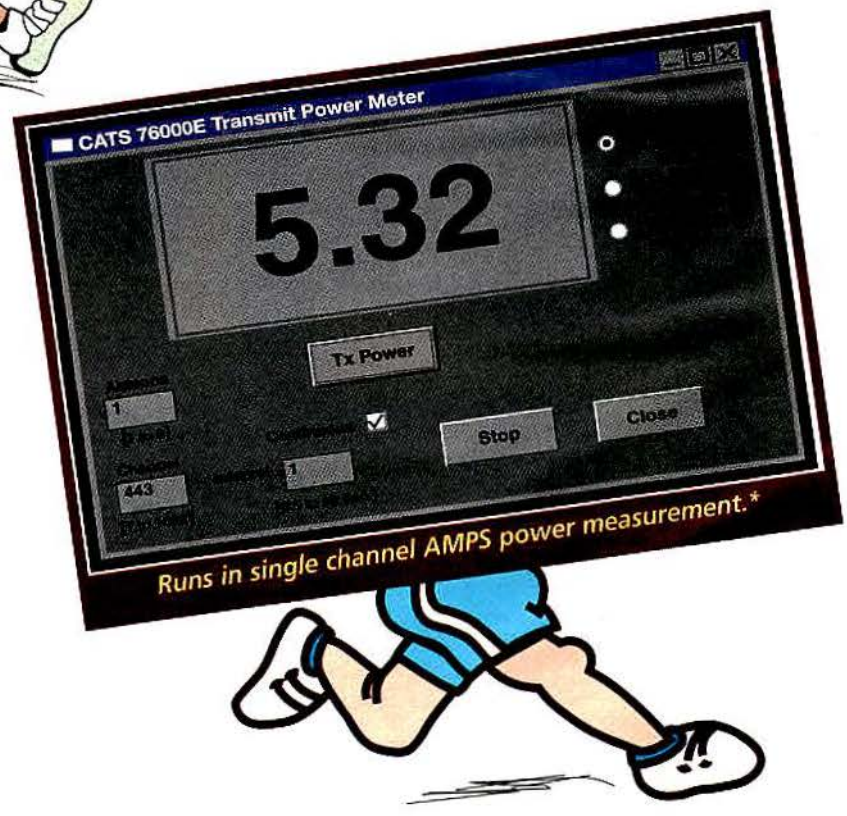
E-Mail: w-wassoc@ix.netcom.com • Web Site: www.ww-manufacturing.com

Circle (6) on Fast Fact Card

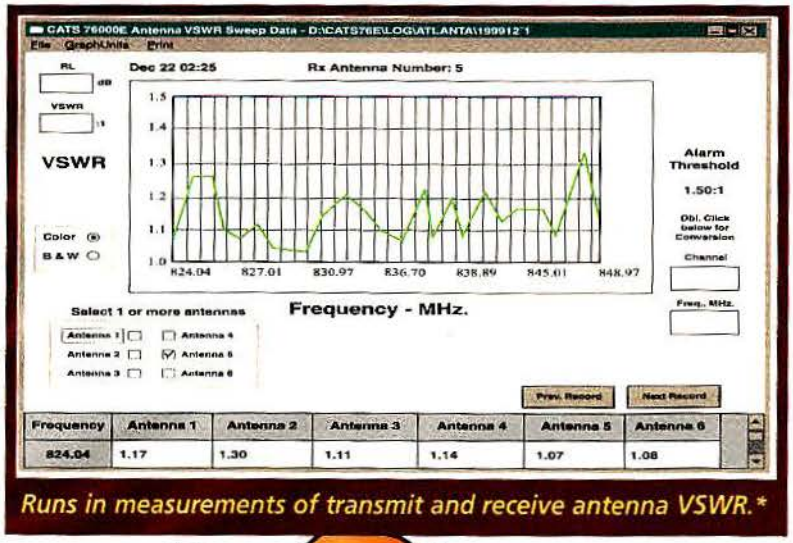
Save serious money. Let our cell site monitor do the legwork for you.



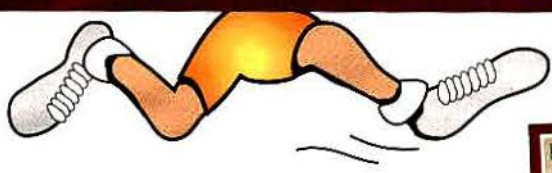
*Runs in total CDMA power and power spectrum.**

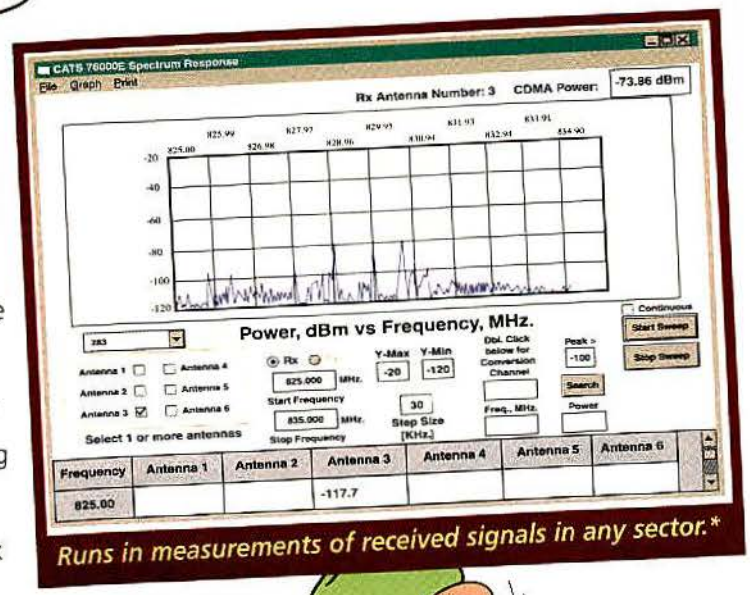


*Actual screen captures



*Runs in measurements of transmit and receive antenna VSWR.**





*Runs in measurements of received signals in any sector.**

Make great strides in cutting your costs with the CATS 76000E. Just install one in each cell site, and you'll be able to remotely monitor everything from one central location.

From this Network Operating Center, you can measure transmitted power and antenna VSWR eliminating the expense of periodic site visits for routine VSWR measurements and power adjustments. You can check CDMA power per carrier to answer real-time performance questions. Detect interference with our in-line spectrum analyzer—even answer lost call questions.

And that's just the beginning. You can remotely diagnose a cell site and arrive at a comprehensive picture of its problems. With this crucial data, you can determine if an on-site visit is necessary. If it is, a technician can be sent fully prepared to solve the problem.

The new CATS 76000E

Install the CATS 76000E. It's an indispensable source for vital cell site information. Call Narda today for an eye-opening demonstration at **631-231-1700.**

Once you do, your budget will have a lot more legs.

narda
microwave-east
an L3 communications company
www.nardamicrowave.com

ISO9001

Visit us at IWCE, Booth #1266.

Circle (7) on Fast Fact Card

NEXT MONTH—MAY 2000

FEATURES: 800MHz conventional systems; implementation of a new 9-1-1 dispatch center; Wireless@Work.

PLUS: Robert H. Schwaninger Jr.'s "In the Public Interest"; Harold Kinley's "Technically Speaking"; David Dunford's "Public Safety: 10-2"; editorial commentary from Don Bishop and David Keckler; Product focus—what's new in base station antennas.

AND IN THE MONTHS TO COME:

Filters; power supplies; interconnection; APCO pre-show; portable radios; installing equipment mounts; mobile radios.

Visit us on the web at www.mrtmag.com

ADVERTISING SALES OFFICES

OVERLAND PARK, KANSAS
Joyce Bollegar, 913-967-1840,
East Region (including Eastern Canada)
Fax: 913-967-7249
Email: **joyce_bollegar@intertec.com**
Dawn Rhoden, *Classifieds,*
913-967-1861, Fax: 913-967-1735
Email: **dawn_rhoden@intertec.com**
Lori Christie, *List Rental Services Representative,*
913-967-1875, Fax: 913-967-1897
Email: **lori_christie@intertec.com**
9800 Metcalf Avenue
Overland Park, KS 66212-2215

SANTA ROSA, CALIFORNIA
Dennis Hegg, *West region (including Alaska, Hawaii and Western Canada)*
Phone: 707-541-3763, Fax: 707-541-3721
Email: **dennis_hegg@intertec.com**
3428 Mendocino Ave.
Santa Rosa, CA 95403

ENGLEWOOD, COLORADO
Mercy Contreras, *Group Publisher*
Phone: 720-489-3199
Fax: 720-489-3253
Email: **mercy_contreras@intertec.com**
5680 Greenwood Plaza Blvd., Suite 100
Englewood, CO 80111

LONDON
Stephen Bell, *International*
Phone: +44 208 286 8889
Fax: +44 208 286 8898
Email: **stephenbell@email.msn.com**
P.O. Box 98
Worcestor Park, Surrey, KT4 8WB
United Kingdom

CORRESPONDENCE: Editorial correspondence should be addressed to P.O. Box 12960, Overland Park, KS 66282-2960. tel. 913-341-1300; fax: 913-967-7250; **mrt@intertec.com; www.mrtmag.com.**

MOBILE RADIO TECHNOLOGY provides technical information to dealers; to private wireless, public safety, public service, community repeater, SMR, ESMR, paging, cellular and PCS system operators; mobile radio equipment manufacturers: manufacturers' representatives, distributors: engineering and consulting firms; national, state and local government and public safety agencies; transportation companies; petroleum and energy products companies; public utilties; and others allied to the field.

BACK ISSUES: Copies of most issues printed within the past two years are available for $10 per issue; older issues are not. Call customer service at 800-441-0294.

This publication is available in paper or electronic format from Information Express, 3221 Porter Drive, Palo Alto, California 94304-1225. Contact Information Express at 650-494-8787, or visit IE online at **www.express.com.** This publication is also available via microform and/or electronic databases from Bell & Howell Information and Learning, 300 N. Zeeb Road, P.O. Box 1346, Ann Arbor, MI 48106-1346. Contact Bell & Howell at 800-521-0600 (734-761-4700 outside North America) or check the Web site **(www.uml.com)** for additional information on format availability.

Audited circulation.

BPA INTERNATIONAL
AMERICAN BUSINESS PRESS ABP

You just can't win without a good, solid bench.

Stop by our Booth #543 at IWCE and ask about our new ASTRO® 25 Service Monitor!

As every great team knows, it's not just the players that make up a winning team. It's having the right equipment and solid back-up support that can make all the difference in the world.

When it comes to servicing two-way equipment, one of the best teams in the business is Motorola. We offer support solutions for all your bench requirements – from the R2600 family of Communication System Analyzers...to Chipmaster® Surface Mount Rework Stations and Fluke® Hand-held Meters.

The fact is, we only team up with proven leaders. So you can be sure we'll supply you with dependable test equipment and replacement parts to keep your radios performing optimally.

Now, thanks to our new *"Test Equipment Catalog,"* ordering equipment has never been easier! It's the fastest way to find exactly what you need, when you need it. Simply fill out and return the attached card for your free copy. Hurry! Supplies are limited.

To make sure you have the right players on *your* bench, call Motorola. Our servicing solutions help ensure *you* win... every time!

MOTOROLA ORIGINAL

MOTOROLA

CALENDAR

2000

April

10–12: APCO North Central Regional, sponsored by the Association of Public-Safety Communications Officials–International, Holiday Inn, Worthington, OH. Contact: Jay Somerville, 614-761-6530 or Web site **www.apcointl.org.**

May

8–11: Telecommunications Resellers Association Spring Conference and Exposition, Philadelphia Marriott. Contact: 202-835-9898 or Web site **www.tra.org.**

15–18: Spring Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hotel Pacific Tokyo, Tokyo. Contact: 81-468-40-3552 or email **matumoto@mars.yrp.nttdocomo.co.jp.**

17–19: Site Owners & Managers Alliance (SOMA) Conference, sponsored by the Personal Communications Industry Association, Kansas City, MO. Web site **www.pcia.com.**

30–June 1: Canadian Wireless, sponsored by the Canadian Wireless Telecommunications Association, Toronto. Contact: 613-233-4888, ext. 102, or Web site **www.cwta.ca.**

June

4–8: Supercomm, sponsored by TIA and USTA, Georgia World Congress Center, Atlanta. Contact: 800-278-7372.

12–13: AMTA Leadership Conference and Annual Meeting, sponsored by the American Mobile Telecommunications Association, Sheraton Suites, Alexandria, VA. Contact: 202-331-7773 or Web site **www.amtausa.org.**

25–29: UTC Telecom, sponsored by UTC, The United Telecom Council, Phoenix. Contact: 202-857-1881 or Web site **www.utc.org.**

July

16–19: Forestry Conservation and Communications Association National Conference, Elms Resort & Spa, Excelsior Springs, MO. Contact: 573-751-4115, ext. 172.

August

13–17: Association of Public-Safety Communications Officials—International (APCO) National Conference, Boston. Contact: 904-322-2500 or Web site **www.apcointl.org.**

September

19–22: Fall Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Seaport Hotel, Boston. Contact: 904-322-2500.

26–29: Personal Communications Showcase, sponsored by PCIA, McCormick Place, Chicago. Contact: 703-739-0300 or **www.pcs00.com.**

October

4–7: Private Wireless Spectrum Management Conference; sponsored by the Industrial Telecommunications Association, the Council of Independent Communication Suppliers and USMSS, Grand Hyatt Hotel, Washington. Contact: Ray Wisniewski, 703-797-5123; email: **ray@ita-relay.com.**

November

12–15: Telecommunications Resellers Association Fall Conference and Exhibition, sponsored by TRA, Anaheim, CA. Contact: 202-835-9898 or Web site **www.tra.org.**

13–14: AMTEX, sponsored by the American Mobile Telecommunications Association, Ft. Lauderdale, FL. Contact: 202-331-7773 or Web site **www.amtausa.org.**

15–18: Communications Marketing Conference, sponsored by the Communication Marketing Association, Sheraton Colony Square, Atlanta. Contact: 404-892-2600, ext. 300 or Web site **www.commktga.com.**

EDITORIAL INDEX

Whether your system needs indoor or outdoor wireless testing... Berkeley has the solution!

INDOOR MICROCELL TEST EQUIPMENT

www.bvsystems.com/microcell

Mongoose

SIGNAL STRENGTH METER

For indoor sweeps by propagators.

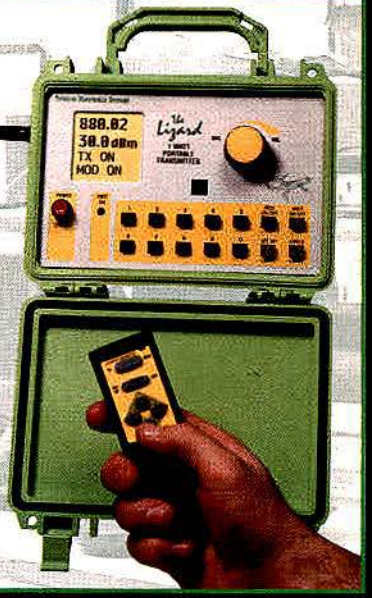
- Internal memory stores signal strength
- Scans up to 21 channels
- Displays best 3 channels simultaneously
- Data can be output to a PC with a serial cable
- Audio can be heard through the headphones or internal speaker
- Includes rechargeable Ni-Cad battery/charger

The Lizard

1 WATT PORTABLE TRANSMITTER with REMOTE CONTROL

For indoor coverage testing.

- Dynamically adjustable power control from 1 milliwatt to 1 watt output
- Infrared remote control adjusts power output, frequency and on-off >25 feet
- Super bright 128 x 128 graphic LCD with backlight
- Battery operated



DRIVE-TEST AND WALK-ABOUT PROPAGATION ANALYSIS EQUIPMENT

www.bvsystems.com/drivetest

The Gator

CLASS A TRANSMITTER SERIES

For measuring signal propagation, positioning antennas, setting power levels or validating coverage.

- Available in either 25 Watt Class A, or 45 Watt Class A (10 or 20 Watt Class A for PCS) FCC Type Accepted
- Built-in agile frequency synthesizer
- Power control in 0.1 dB increments
- Remote controllable
- VSWR antenna protection
- Weighs 25 pounds

The Best Selling Transmitter

The Fox

RUGGED HAND-HELD SIGNAL STRENGTH METER

Measures RF propagation coverage and detects "RF Shadows".

- High measurement rate, more than twice that of Dr. Lee's recommended 40 λ
- Internal eight channel differential GPS
- PCMCIA memory system for post processing data

BERKELEY VARITRONICS SYSTEMS WIRELESS PRODUCTS

Liberty Corporate Park, 255 Liberty St., Metuchen, NJ 08840

Phone: 732-548-3737

www.bvsystems.com

Fax: 732-548-3404 • E-mail: info@bvsystems.com

Models Available:

- PAGING (POCSAG/FLEX) *NEW!*
- IS-136
- CELLULAR
- GSM
- ISM
- LMR
- PCS
- iDEN/SMR
- WCS

Custom Frequencies Upon Request

Circle (9) on Fast Fact Card

The IWCE/Las Vegas experience

LAS VEGAS—The first time I attended IWCE three years ago was also the first time I had ever been here. I had never really considered visiting here as a tourist because I don't *really* gamble. So, like many of you, my job brought me to this city in the middle of the desert. The first thing I saw from the plane was the Luxor hotel, which looked like it came straight from Egypt (or another planet). And then, of course, my first cab ride in Vegas was interesting, with the driver taking us on a *scenic* route. (Everyone else beat us to the Mirage by half an hour). Now I look forward to visiting the city each year. Spring wouldn't seem the same without it.

Whether you are attending IWCE for the first or the 24th time, you are finding yourself in a surreal world, full of gobs of people, lights and quarters. You may have forgotten the people back home, but don't forget to visit the booths and attend some sessions between trips to the slot machines and the blackjack tables.

At the end of the day, however, do check out some of the sights and sounds of Vegas. If you don't want to gamble, you can watch *other* people lose their money, do some rides or see a show.

For the mobile radio daredevils in the crowd, the Big Shot ride on top of the Stratosphere and the New York, New York roller coaster provide some thrills. Try taking a portable radio to the top of the Stratosphere and describing the experience to your acrophobic co-workers. I recommend both rides, but not after a buffet dinner at the Rio.

For sci-fi fans, the Las Vegas Hilton, adjacent to the Las Vegas Convention Center, features "Star Trek: The Experience." It includes a History of the Future museum, Voyage Through Space and Quark's Bar & Restaurant. Our magazine staff includes a few Trekkers who recommend the experience.

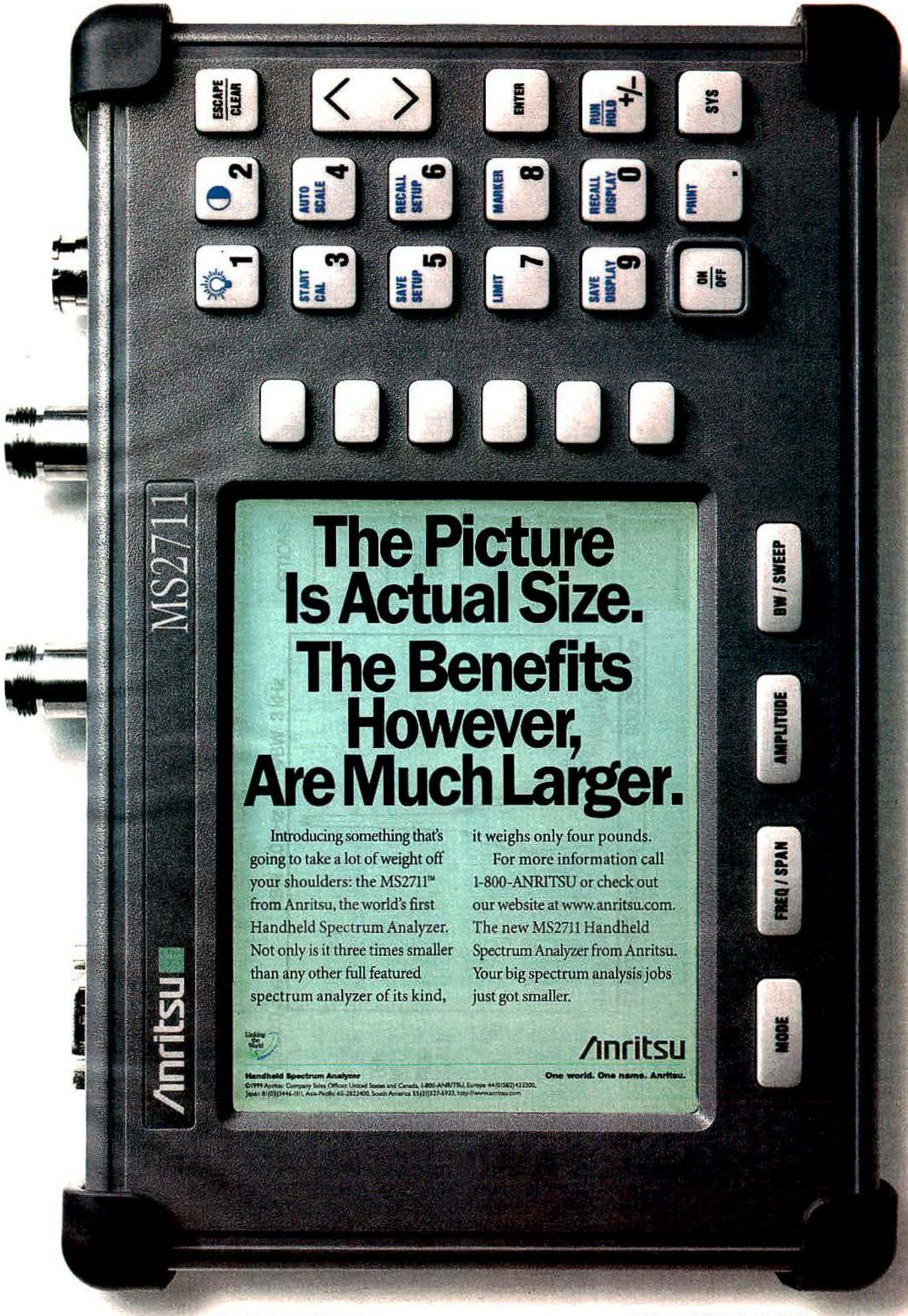
Shopping is always an option, too, especially at the Forum shops at Caesar's Palace. And there's always the $100-per-ticket shows. (I hear that Cirque du Soleil's Mystere is the one to see.)

This year, IWCE attendees will have two new hotels to explore: the Venetian Resort Hotel & Casino and Paris Las Vegas. The Venetian provides gondola rides and Madame Tussaud's Celebrity Encounter, a museum with 100 wax figures. The Paris Las Vegas features the "Eiffel Tower Experience" with an elevator ride to the top of the tower, which has an observation deck.

So after a full day on your feet at IWCE, spend the *night* on your feet in Vegas. Las Vegas *is* "Disney World" for adults, so take the opportunity to step out of the real world for awhile.

—Nikki Chandler

nikki_chandler@intertec.com



Circle (11) on Fast Fact Card

Visit us at IWCE, Booth #1249.

What's the buzz?

By Robert H. Schwaninger Jr.

LAS VEGAS — It's shoooow time! This issue of *MRT* is also being circulated around the IWCE show floor to the thousands of folks who have come to learn about the opportunities and challenges in our industry. They're here to view the rows and rows of exhibits, to witness the dialogue between the regulators and the regulated ... and to be found drunk under a roulette table with a showgirl named Mimi LaFlame (those feathers tickle).

Every year, local operators, public safety folks, regional paging companies and a host of others descend on Las Vegas for IWCE to pick up on the happenings and rumblings among their cohorts in communications. They swap tips, lies, stories and jokes while trying to calculate how well they are doing compared to some other guy's business located on the other side of the country.

And, they listen.

So, what's the *buzz* this year? What's new and what's still the same? Where are we heading, and where will we be when we get there? All of the gurus will be here with cracked crystal balls and used tea leaves to give predictions and to pontificate on the future of the industry. And I, your humble columnist, will be among them. I'm dishing out advice—wanted and unwanted—and ideas about how to keep what you have and to get more of what you want.

The buzz this year is *business*. Not equipment, not performance, not propagation, not rules, regulations or policy. This year we are getting down to business about business. The old days of attendees only talking about throughput, guy anchors, fried PAs, lightning strikes and the mundane but important aspects of installation techniques is giving ground to new conversations. The phrase "multiples of cash flow" and the calculations that flow from it will be discussed many times more than voltage standing wave ratios will be.

Now, I know that hoards of techs are attending the technology sessions, gleaning the newest information about equipment and RF design. And, I know that the public safety guys will be treated to a track designed specifically for those spectrum-rich/budget-poor servants from local governments across the nation.

But the *rest* of us will be talking about making money.

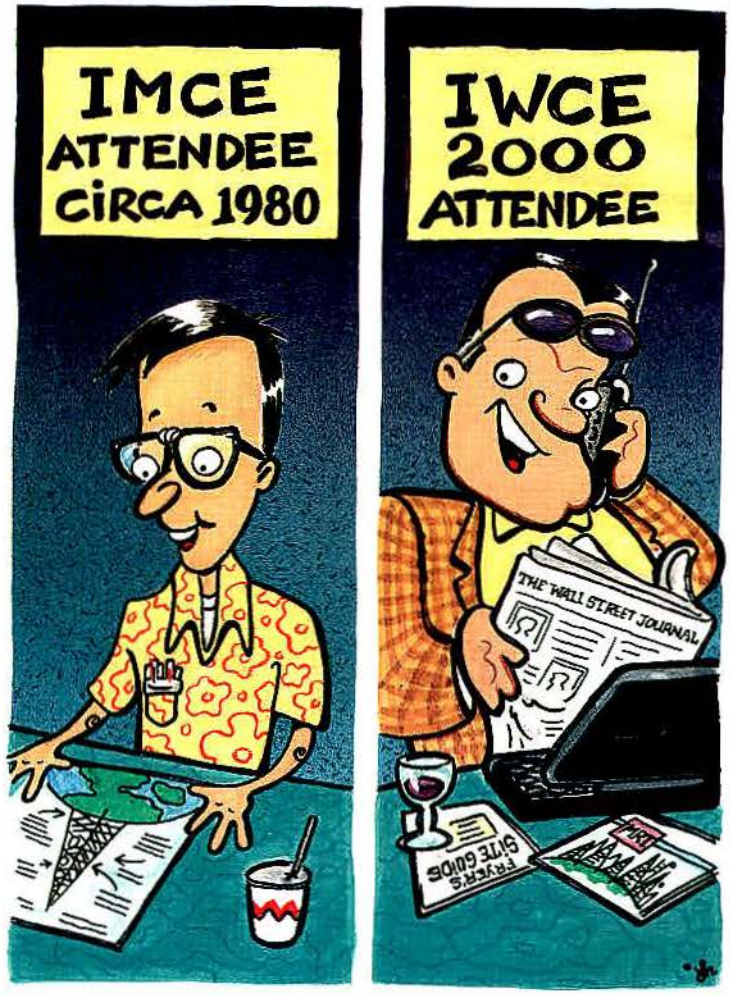


Illustration by John Hayes

As the sophistication of the local operators has increased, and the competition has become more intense, the industry has winnowed out the hobbyist, the ham-turned-local-operator and the feint of finance. Local paging operators spit out RPU numbers like they were drafting a 10Q for an SEC filing. SMR operators are talking about multiples of cash flow, capital gains and the cost of money to finance relocation vs. the sale of channels.

Tower operators are calculating the ROI of tower building vs. tower purchase vs. tower sale and are following the path of most profitability, employing terms that more often are used by investment bankers rather than dispatch operators. People are talking about "markets" rather than customers. It's the language of business.

To be sure, the industry still has its Reubens. Although the entire industry is gaining momentum rapidly, there will always be those that lag behind. And for all of the talk about capital gains and reinvestment, a local operator who doesn't know how to construct and operate a system will always be at a disadvantage. The practicality of operation will always be a priority. We are all still creatures of RF design.

But in bygone years, operators would sit around the bar and talk primarily about product performance in terms of RF efficiency. Now, operators are adding a new and quickly spreading subject to their conversations: a focus on RF efficiency translated into *profitability*.

So, what's the buzz? The buzz is the business education of the local operator. It's a combination of The Wharton School of hard knocks, tough lessons learned and new ideas about how to get the most dollars out of an increasingly competitive marketplace.

For example, when a local operator

Schwaninger, *MRT's* regulatory consultant, is the principal in the law firm of Schwaninger & Associates, Washington, which is counsel to Small Business in Telecommunications. Schwaninger is also a member of the Radio Club of America.

Introducing the **AdvanceTec** *Battery Maintenance Solution:*

You only have your *"Memory"* to lose!

Charge and condition your battery on a regular basis using the AdvanceTec Negative Pulse Reconditioning Charger and keep it memory free, in peak condition and double or even triple its usable life. Analyze the battery every 30 - 60 days to confirm its condition. The AdvanceTec Battery Maintenance Solution eliminates the guess work from battery care.

The AdvanceTec Negative Pulse Reconditioning Charger

The Reconditioning Charger uses a combination high current charge with regularly spaced negative current pulses. These negative current pulses "burp" the "Memory" from the battery, restoring the battery's optimum charge.

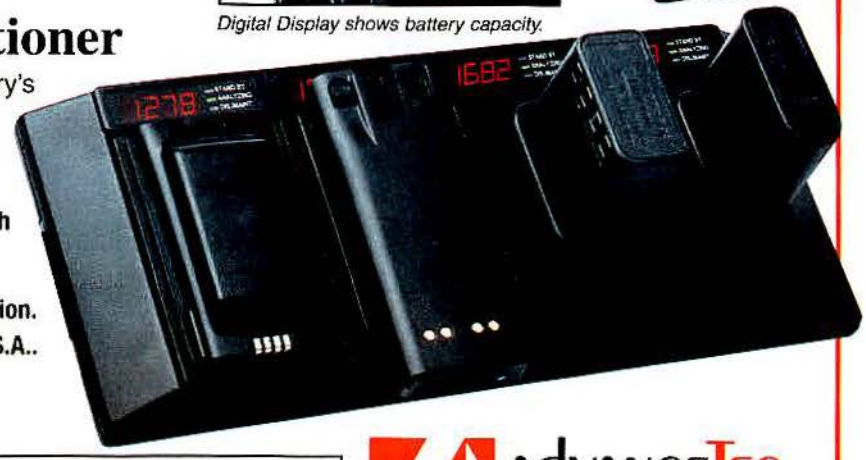
- **Prevents memory.**
- **Reconditions & rapid charges in a signal process in approx.1 hr.**
- **Keeps battery at peak condition without overcharging.**
- **Safely top off the battery.**
- **Can be used in both car & office.**
- **Single or 4 station.**
- **Made in the U.S.A.**

Digital Display shows battery capacity.

The AdvanceTec *Pulse* Analyzer™ Conditioner

Eliminates the guess work from your battery's daily life. Simple to operate. Insert the battery and the unit will do the rest. Know exactly how long your battery will last.

- **Analyzes, charges & conditions in a single process.**
- **No buttons to press.**
- **No programming necessary.**
- **Digital display shows capacity of battery.**
- **Compatible with Ni-Cd & NiMH batteries.**
- **Single or 4 station.**
- **Made in the U.S.A..**



Call us today for our 30 day No-Strings Attached FREE trial & evaluation unit.

You only have your *"Memory"* to loose!

For Sales Information Call: 1-800-881-8211

ADVANCETEC INDUSTRIES INC

451 N.E. 189th St., Miami, FL 33179
Tel: (305) 651-3211
Fax: (305) 651-3296
E-mail: sales@advancetec.com
www.advancetec.com

sells air time to a school bus operator, he is now more likely to calculate the effect on churn, earnings, and market penetration than he is to consider the cost of the mounting hardware. He may employ industry multiples on cash flow for determining the value of the contract. He may characterize the deal as "positioning" rather than simply as customer service. He may leverage the deal with a concurrent tower lease agreement, raising his cash flow for both active and reactive purposes to augment the overall value of his business and its assets. And, he may provide a far greater incentive for the saleswoman who created and closed the deal than for the supervising technician who will install the system.

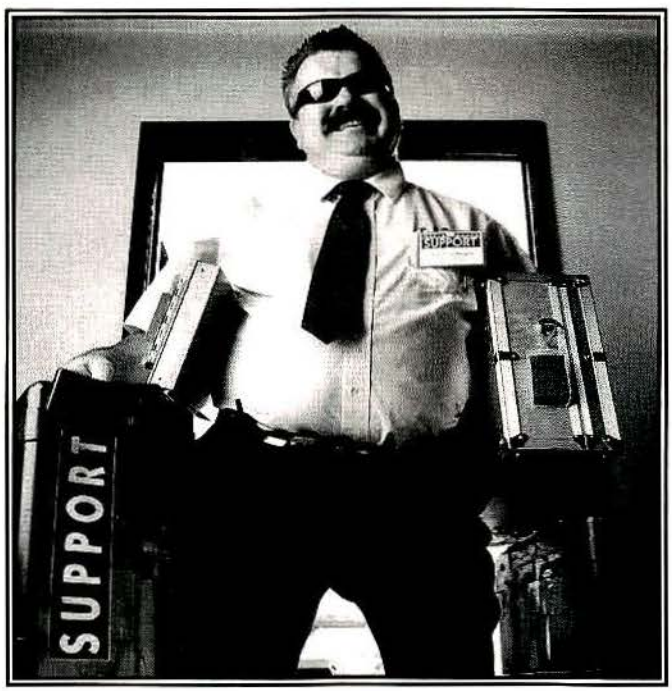
When he makes money, the local operator is more likely to consider whether profits are better applied to expansion, enhancement, personnel, sales, marketing, or outside investment based on an expected earnings calculation prepared by a CPA. I'm getting numerous calls from clients who are focusing on valuations of assets and potential investment in expansion. It used to be that they just wanted to know why frequency coordinators make all the money.

If you run into me, I will speak to you about doing an audit on your business (and this activity is a *must* for Mimi LaFlame). Not the kind of audit that a CPA does, but one that involves breaking down your business into titles, assets, contracts, and licenses to determine status and direction for future actions. Or, at least, we'll talk about an approach that will work for you in setting up ongoing evaluation criteria for taking litmus tests on reasonable revenue expectations.

So, what should you do to make sure you get the most out of IWCE? First, talk to me if you've got a new joke—or if you're dating Mimi's sister. Second, ask the right questions, then *listen*. The right question relates all aspects of operation and equipment purchase to either long-term or short-term revenue potential. When speaking with vendors, find out how their products and services will translate into market growth or higher revenues. Forget the bells and whistles—unless every time the box beeps, it means money.

Oh, yeah—drop in on the opening session. I'm giving the keynote address, and maybe I'll be able to answer a few of your questions. Or, maybe I'll just make you laugh and leave the hard stuff to the other guys. After all, everything I know about spreadsheets I learned from a chambermaid. ■

AT $3 PER MINUTE PLUS AIRFARE AND EXPENSES, YOU DON'T NEED THIS DISPATCH CONSOLE SUPPORT GUY, YOU NEED A MEDIC.



Only our built-in MEDIC Diagnostics can save you from the high support costs and downtime of today's increasingly complex Radio Dispatch

MEDIC Diagnostics

console systems. In fact, our MEDIC can save over 50% in typical support costs.

The MEDIC Diagnostics application is built into our state-of-the-art UltraCom NT™ Dispatch Console System. It is a totally digital, 32-bit Windows NT system with fully programmable touch screens and an integrated system customizer. You'll save big on trouble shooting and never pay for system program changes. And even software upgrades are free for the life of the system.

We put our 20 years of experience into building the most advanced integrated diagnostics in the industry. Our MEDIC Automatic Diagnostics constantly works in the background to find faults and automatically switches to back up resources when needed. It even identifies plug-in board faults often enabling replacement by non-technical staff. Complete explanations on all error messages recommend clear and corrective action.

MEDIC Manual Diagnostics often locates faults down to the component level. There are even links on error descriptions to our on-screen schematics. And MEDIC keeps a complete history of all your error messages. There's remote access to all diagnostics and a built-in audio signal generator to speed up locating internal and external problems.

So if you want to cut downtime and save on support, get the most cost effective console system on the planet, the UltraCom NT. You won't need high priced technicians, you'll have MEDIC saving you money.

Introducing the UltraTel NT our 100% user programmable, integrated analog phone line solution. Not just a stand-alone application, it's totally integrated into our UltraCom NT system. Call today to find out more. And be sure to look for our new NENA compliant 9-1-1 product coming soon.

Modular Communication Systems, Inc. 13309 Saticoy St. North Hollywood, CA 91605.
E-mail: moducom@ix.netcom.com

MODUCOM

**COST EFFECTIVE NOW.
MORE COST EFFECTIVE OVER TIME.**

WE'LL PROVE IT. DEMO OUR SOFTWARE SYSTEM FREE AT WWW.MODUCOM.COM OR 818-764-1333

Visit us at IWCE, Booth #765.
See us at North Central APCO, 4/10-4/12, Booth #152

Circle (15) on Fast Fact Card

Cramming: Part II

Can we please get out of the car now?

By David O. Dunford

Last month (*MRT*, March) we discussed prewiring of vehicle-mounted equipment to help speed the actual installation. There are actually two "in-the-car" sessions for a typical installation. The first visit of the vehicle to the shop involves removing items from *last year's* installation. While generally a filthy and disgusting job, this task is really an installer's scavenger hunt. Our techs regularly find blades, knives, drugs, drug paraphernalia, pens, pencils, scraps of paper, a variety of foodstuffs, uniform buttons, pins and clips—but almost never any money. (What does this mean?)

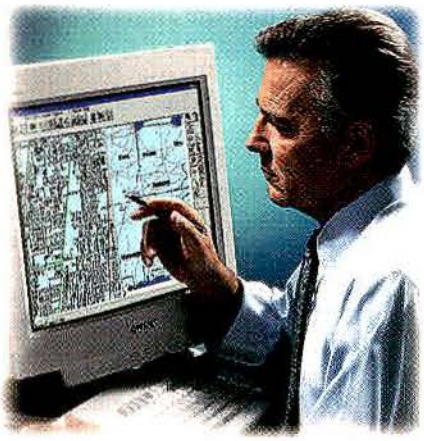
After separating the recoverable electronic equipment from the unusable accessories, hardware and drink residue, the next step is a thorough cleaning (of the equipment) and then a trip to the test bench to verify proper operation of the items slated for reinstallation. Important safety tip: After the "wire whacking" and equipment removal, be certain to ensure proper functioning of the vehicle's convenience accessories such as the ignition system, brake lights, horn and headlights before returning the vehicle to its owner agency.

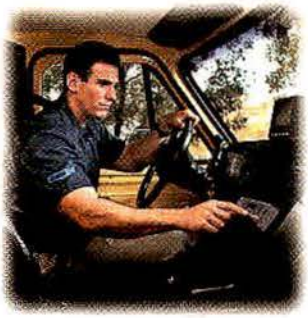
After prewiring the equipment console and control center (the trunk box), we begin the "in-the-car" session with mechanical installation and then electrical wiring of the equipment. After several nasty incidents involving electric drills, lengthy snags in the floor carpeting and mysterious holes in a variety of under-vehicle drive train components, we've decided to either mount equipment on existing bolts (using the car seat studs or seat belt bolts) or into holes punched with an awl. Fortunately, there are several excellent, commercially available modular console systems that can make the technician's job much easier. If installed in accordance with manufacturer instructions, these products can also offer some liability protec-

Dunford, MRT's public safety consultant, is manager of technical services for the Lenexa, KS, police department. He is a member and past president of the Kansas Chapter of the Association of Public-Safety Communications Officials—International. You can email Dunford at **mrt@intertec.com.**

Photo 1. This bracket (above) which mounts between the car's bucket seats, was devised by the Lenexa Police Department and was fabricated by a local welding shop.
Photo 2. As shown at the right, the bracket stows the shotgun and assault rifle vertically, nearly behind the officer. Non-communications vehicle and officer accessories often have to be accommodated in a complete radio installation.

securicor wireless





Securicor Wireless Inc., formerly known as Intek Global Corporation, is the leader in spectrum-efficient wireless two-way voice and data equipment and services.

The Midland FM land mobile radio and 220MHz LM equipment lines have been joined with Data Express mobile data products and RoameR One airtime services under the Securicor Wireless name.

We are now better positioned to offer wireless solutions to support your business and improve your profitability.

New name
better service

best solutions

securicor *wireless*

www.securicorwireless.com
www.securicor.com

Visit Booth 811 at IWCE

Securicor Wireless Inc. 1690 North Topping Avenue Kansas City MO 64120 **Securicor Wireless Inc.** 99 Park Avenue 18th Floor New York NY 10016

Circle (16) on Fast Fact Card

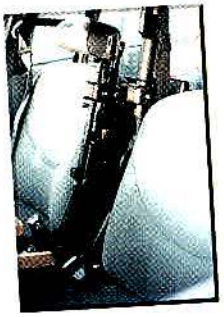
tion over "homemade" racks or frames in the event that the equipment mount becomes an airborne, in-cab missile during a pursuit or an abrupt stop.

Mounting a single shotgun in the cab is a difficult-enough task. Our department issues two long guns—a shotgun and an assault rifle—for each police cruiser. Photo 1 on page 18 shows the bracket we devised and had fabricated by the local welding shop. It conveniently mounts between the car's bucket seats to stow the weapons vertically, nearly behind the officer, and completely clear of the airbag deployment zone.

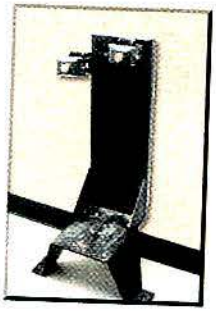
Mobile video recording systems are fairly new additions to public safety fleet equipment and are being widely adopted and installed in fleets of all sizes. These units have repeatedly proven their worth and are quickly growing in popularity, but they can be cantankerous installation candidates. Because installation is not just "nuts and bolts," (well—bolts, anyway) substantial technician time is often required for the detailed setup and optimization of these multidisciplinary systems after installation. Common trouble areas include the audio receiver antenna, connections and matching circuitry; external transmit RF signals that interfere with the video signal; and mechanical mounting maladies, especially involving the camera. If the mounting isn't tight, camera shake can induce motion sickness in users viewing playback tapes.

Several years ago as a collision precaution (and as an insurance policy on $2,000 radios), we started mounting the radio components that are housed in the trunk onto a piece of plywood that was securely fastened to the vehicle's body. We discovered two benefits to this technique: First, in a serious crash, the impact would break the radio away from the wood mount, and it would remain (mostly) intact. Second, road salt and moisture wouldn't "wick" up the screws or bolts for the undercarriage into the radio package.

Because computing power is plentiful and cheap, many agencies are adopting it as a strategy to multiply manpower effectiveness. Many federal C.O.P.S. equipment grants rely on computing efficiency to free officers for additional citizen contacts. However, the mobile equipment installer is called on to perform in yet another venue: mobile computing, a discipline that deftly melds the etheral promises of "integrated computing," the vagaries of radio propagation and the restful convenience of arm wrestling.



As with other in-car equipment mounts, several high-quality, commercially made mobile computer stands are available that can make the installer's job easier. These stands may require costly exchanging as new-model vehicles (with different mounting space availability) are introduced. The cup holder can be either part of the computer stand or the console system as well.



These two articles about mobile equipment installation may cover points clearly known to the technicians doing the work, but they might serve as corroboration for shop time and labor charges for the increasingly complex and costly job of "cramming." ■

Time to go Wireless?

Add sizzle to your products with Novatel Wireless' CDPD data modems. Boost your product's performance with remote monitoring capabilities, increasing productivity and decreasing maintenance costs.

Our Custom Engineering team solves your integration headaches, getting you to market faster.

With the smallest and least expensive modem module, it's time to lose the wires.

Expedite CDPD Modem

Visit us at IWCE. Booth #781.

NOVATEL WIRELESS

Wireless Magic by Novatel

1-888-888-9231
www.novatelwireless.com/iwce.htm

Circle (18) on Fast Fact Card

Mobile radio installation notes

By Harold Kinley

The installation of a mobile radio into a vehicle is an important job. In busy commercial radio shops, though, this work is usually assigned to someone who is considered to have less technical ability than the bench or field technicians. This job's importance should not be minimized. In this column we will look at one of the most important issues that the installer must consider.

With the proliferation of all the on-board electronics in today's vehicles, especially microprocessor-based electronics, the proper installation of the mobile radio has become more important than ever. Interference issues are bi-directional—that is, the radio can interfere with on-board electronic systems or the on-board electronic systems can interfere with the radio. Either type of interference is undesirable, but when the radio interferes with the vehicle electronics, the results can be anything from comical to disastrous. (Actually, seldom will the vehicle owner find it to be comical.)

Interference to vehicle's electronics system most often is caused by the mobile radio in the *transmit* mode. However, interference can result when the radio is in the standby or receive mode. Any signal that is radiated or conducted away from the radio is a possible cause of interference to any on-board electronics. This type of problem should be eliminated in the radio design stage through proper internal shielding and decoupling of input/output (i/o) wiring. The one thing that can't be shielded is the antenna, because its job is to radiate the signal from the transmitter and capture the signal for the receiver.

No vehicle should be allowed to leave the installation bay if potentially hazardous or disastrous EMC problems are known or suspected.

Obviously, the choice of antenna placement or location on the vehicle is critical. Antenna location must be considered from both the standpoint of interference *to* vehicle electronics and *from* vehicle electronics. Several factors have to be considered in choosing the proper location for the antenna. These factors include the customer's preference, the best operating location from the receive/transmit perspective, and the best location to minimize any possible electromagnetic compatibility (EMC) problem. It may not be possible to totally eliminate all EMC problems within a given vehicle. However, no vehicle should be allowed to leave the installation bay if potentially hazardous or disastrous EMC problems are known or suspected.

The use of a magnetic-mount antenna can be helpful in checking out various antenna-mounting locations for possible EMC problems. Proper routing of the antenna's coaxial cable is also crucial. Avoid running the cable near other vehicle wiring—especially wiring that connects to the vehicle's electronic control modules. Coaxial cable is not 100% shielded, so there will be some RF leakage from the cable. Because antennas generally are manufactured with the coaxial cable attached, look for antennas with cables that have a higher percentage of shielding—the closer to 100%, the better.

Most mobile radio manufacturers provide information on how to check out any possible interference with the antilock braking system. Follow these instructions carefully and fully to ensure

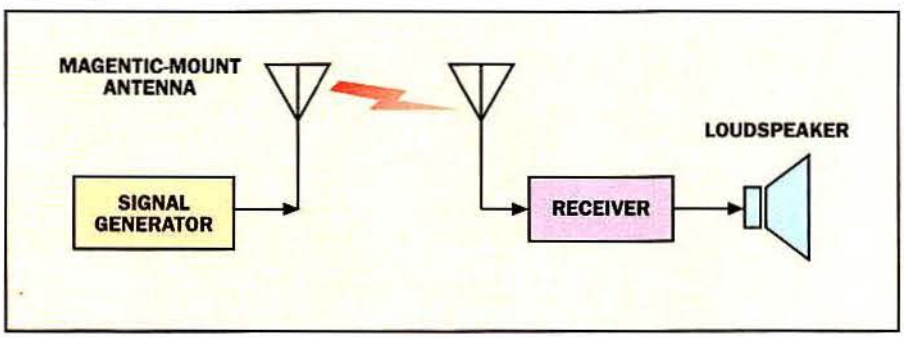


Figure 1. Here, a magnetic-mount antenna is connected to a signal generator to couple the signal to the regular mobile-mounted antenna. This provides fairly tight coupling and minimizes any adverse effects that moving objects or people in the vicinity of the vehicle might have on the test results.

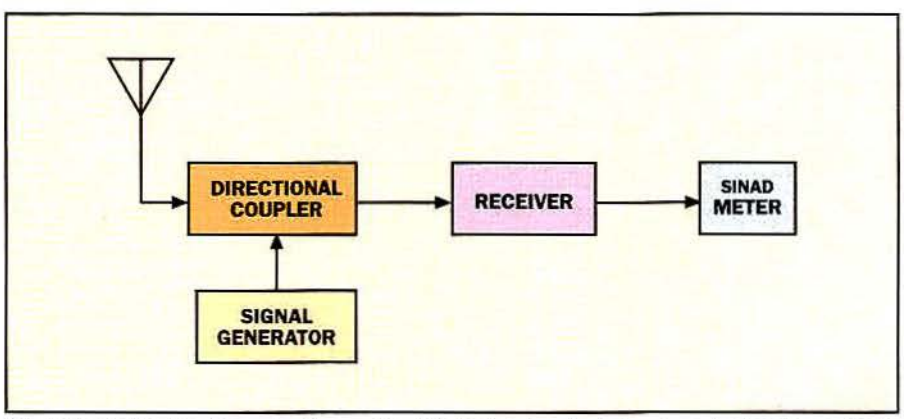


Figure 2. A directional coupler is used in this test setup to determine whether the noise is picked up from the antenna or if it is from common-mode coupling.

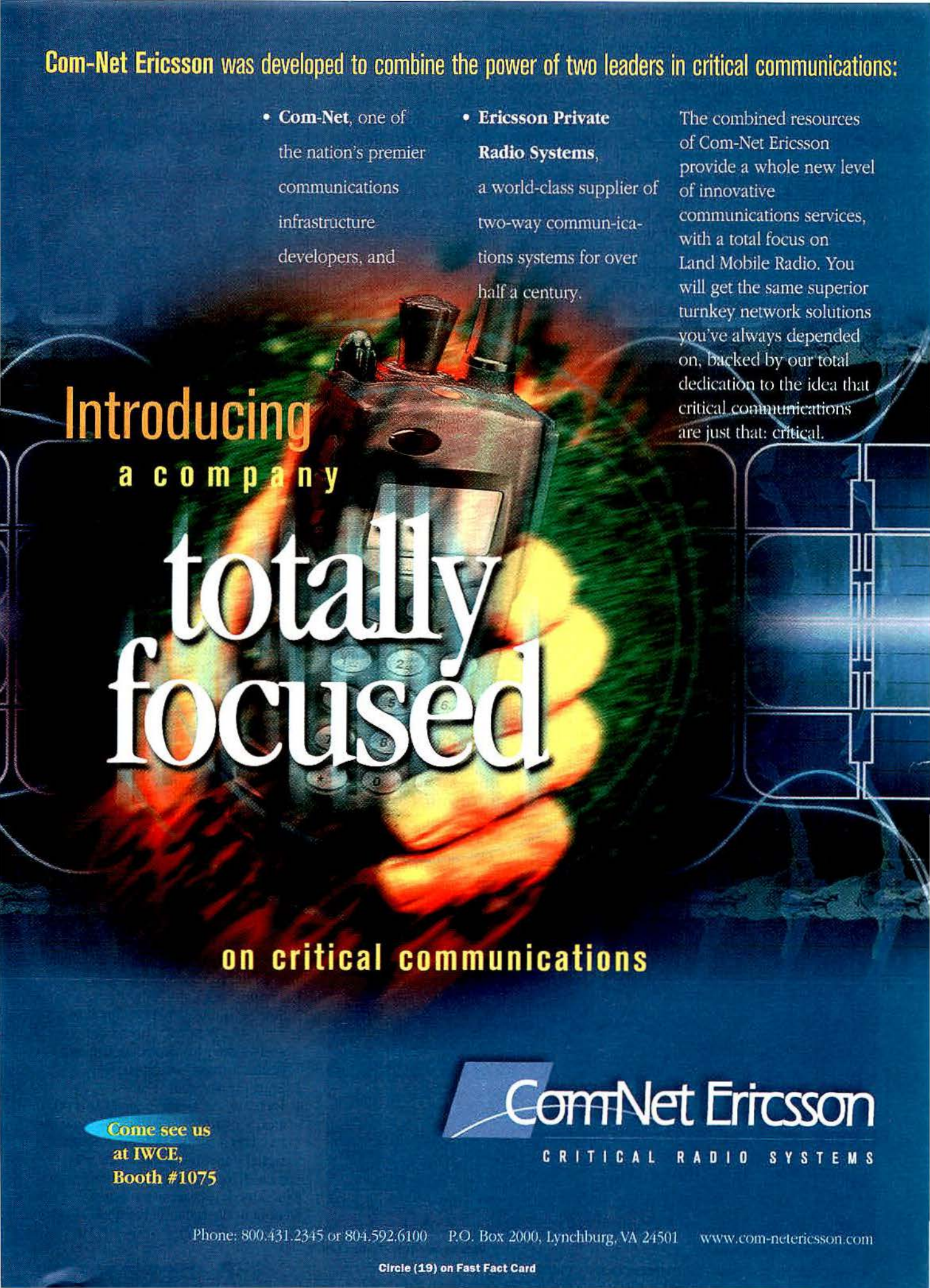
Contributing Editor Kinley, *MRT's* technical consultant and a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual, with Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301.

Kinley's email address is **hkinley@home.com.**

Com-Net Ericsson was developed to combine the power of two leaders in critical communications:

- **Com-Net**, one of the nation's premier communications infrastructure developers, and
- **Ericsson Private Radio Systems**, a world-class supplier of two-way commun-ica-tions systems for over half a century.

The combined resources of Com-Net Ericsson provide a whole new level of innovative communications services, with a total focus on Land Mobile Radio. You will get the same superior turnkey network solutions you've always depended on, backed by our total dedication to the idea that critical communications are just that: critical.



Introducing a company totally focused on critical communications

Come see us at IWCE, Booth #1075

ComNet Ericsson
CRITICAL RADIO SYSTEMS

Phone: 800.431.2345 or 804.592.6100 P.O. Box 2000, Lynchburg, VA 24501 www.com-netericsson.com

Circle (19) on Fast Fact Card

that no EMC problems exist. Check for other EMC problems during a test drive. Check for proper receiver operation and for any interference to the vehicle operation while transmitting. Check *all* operating frequencies.

Figure 1 on page 22 shows a test setup that can be used to quickly determine if the vehicle is causing any interference to the radio receiver. You don't have to connect a SINAD meter to the receiver's audio output at first. The antenna connected to the signal generator is a magnetic-mount antenna that is placed near the vehicle's antenna for signal coupling. If the test antenna is placed near the vehicle's antenna, little coupling loss will occur, and the coupling won't be adversely affected by movement of people or objects around the vehicle. It's the next best thing to closed-circuit coupling—without all the hassle.

With the test setup shown in Figure 1, set the signal generator to the receiver's frequency and modulate the signal generator with a 1kHz tone. With the vehicle's ignition switch turned off and the radio turned on, set the signal generator to produce a usable signal in the radio's loudspeaker with a significant amount of white noise apparent in the background. It should sound slightly better than a 12dB SINAD signal. Next, turn on the ignition switch without starting the vehicle. Listen for any additional noise in the speaker. If none is heard, then start the vehicle and listen for any additional noise. If still none is heard, you're in great shape. If there is only a *slight increase* in noise you're probably still in good shape.

If you notice a significant or drastic increase in noise you should connect the SINAD meter to get a more scientific measurement of just how much the noise is degrading the receiver's *effective* sensitivity. To determine the amount of degradation the noise is causing, do the following:

1. Turn off the vehicle ignition.
2. Set the signal generator level to produce 12dB SINAD at the receiver's audio output. Record the signal generator level in dBm.
3. Start the vehicle.
4. Increase the signal generator level to again produce 12dB SINAD at the receiver's audio output. Record the signal generator level in dBm.

The difference between the signal generator levels in steps 2 and 4 is the amount of degradation the noise is causing to the receiver.

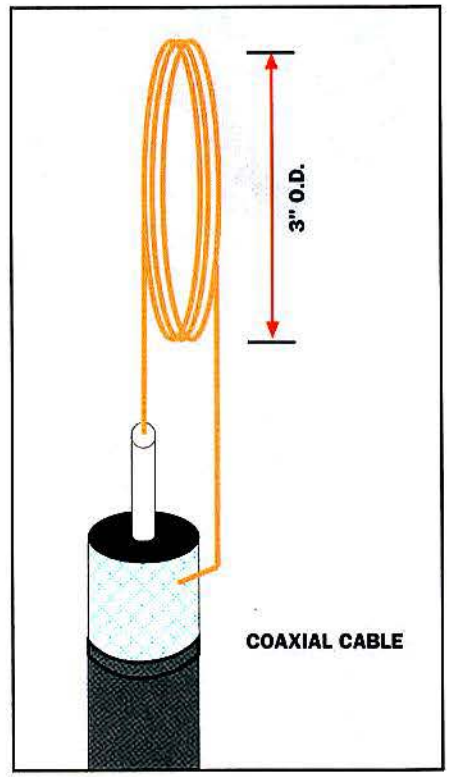


Figure 3. A pickup coil attached to a coaxial cable can be made from three or four turns of stiff, insulated or enameled copper wire (#14 or #16) wound on a diameter of about three inches.

ASTRON CORPORATION 9 Autry Irvine, CA 92618
(949) 458-7277 • (949) 458-0826

E151765 E151765

...POWER ON WITH ASTRON

SWITCHING POWER SUPPLIES...

MODEL SS-10TK

MODEL SS-12IF

SPECIAL FEATURES:

- HIGH EFFICIENCY SWITCHING TECHNOLOGY SPECIFICALLY FILTERED FOR USE WITH COMMUNICATIONS EQUIPMENT, FOR ALL FREQUENCIES INCLUDING HF
- HEAVY DUTY DESIGN
- LOW PROFILE, LIGHT WEIGHT PACKAGE
- EMI FILTER
- MEETS FCC CLASS B

PROTECTION FEATURES:

- CURRENT LIMITING
- OVERVOLTAGE PROTECTION
- FUSE PROTECTION.
- OVER TEMPERATURE SHUTDOWN

SPECIFICATIONS:

INPUT VOLTAGE: 115 VAC 50/60HZ
OR 220 VAC 50/60HZ
SWITCH SELECTABLE

OUTPUT VOLTAGE: 13.8VDC

AVAILABLE WIH THE FOLLOWING APPROVALS: UL, CUL, CE, TUV.

MODEL SS-18

DESKTOP SWITCHING POWER SUPPLIES

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SS-10	7	10	1¼ x 6 x 9	3.2
SS-12	10	12	1⅝ x 6 x 9	3.4
SS-18	15	18	1⅝ x 6 x 9	3.6
SS-25	20	25	2⅞ x 7 x 9⅜	4.2
SS-30	25	30	3¾ x 7 x 9⅜	5.0

MODEL SS-25M

DESKTOP SWITCHING POWER SUPPLIES WITH VOLT AND AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SS-25M*	20	25	2⅞ x 7 x 9⅜	4.2
SS-30M*	25	30	3¾ x 7 x 9⅜	5.0

MODEL SRM-30

RACKMOUNT SWITCHING POWER SUPPLIES

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25	20	25	3½ x 19 x 9⅜	6.5
SRM-30	25	30	3½ x 19 x 9⅜	7.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25	20	25	3½ x 19 x 9⅜	6.5
SRM-30	25	30	3½ x 19 x 9⅜	7.0

MODEL SRM-30M-2

2 ea SWITCHING POWER SUPPLIES ON ONE RACK PANEL

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25A-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30A-2	25	30	3½ x 19 x 9⅜	11.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30M-2	25	30	3½ x 19 x 9⅜	11.0

MODEL SS-12SM/GTX

MODEL SS-IDEFJ-98

CUSTOM POWER SUPPLIES FOR RADIOS BELOW

EF JOHNSON AVENGER GX-MC41
EF JOHNSON AVENGER GX-MC42
EF JOHNSON GT-ML81
EF JOHNSON GT-ML83
EF JOHNSON 9800 SERIES
GE MARC SERIES
GE MONOGRAM SERIES & MAXON SM-4000 SERIES
ICOM IC-F11020 & IC-F2020
KENWOOD TK760, 762, 840, 860, 940, 941
KENWOOD TK760H, 762H
MOTOROLA LOW POWER SM50, SM120, & GTX
MOTOROLA HIGH POWER SM50, SM120, & GTX
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
UNIDEN SMH1525, SMU4525
VERTEX — FTL-1011, FT-1011, FT-2011, FT-7011

Circle (21) on Fast Fact Card

NEW SWITCHING MODELS

SS-10GX, SS-12GX
SS-18GX
SS-12EFJ
SS-18EFJ
SS-10-EFJ-98, SS-12-EFJ-98, SS-18-EFJ-98
SS-12MC
SS-10MG, SS-12MG
SS-101F, SS-121F
SS-10TK
SS-12TK OR SS-18TK
SS-10SM/GTX
SS-10SM/GTX, SS-12SM/GTX, SS-18SM/GTX
SS-10RA
SS-12RA
SS-18RA
SS-10SMU, SS-12SMU, SS-18SMU
SS-10V, SS-12V, SS-18V

Visit us at IWCE, Booth #465.

*ICS – Intermittent Communication Service

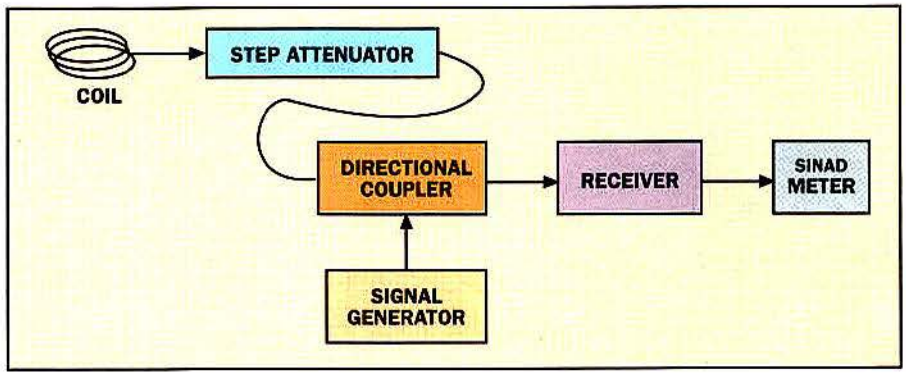


Figure 4. This test setup can be used to help "home in" on the noise source in the vehicle. As the pickup coil is brought closer to the noise source, the attenuation must be increased to maintain about the same SINAD reading at the receive input.

Is the noise being caused by common-mode coupling, or is it picked up by the antenna? The test setup shown in Figure 2 on page 22 can determine this. Here, a directional coupler is used to couple the signal generator to the receiver input. To determine if the antenna is the primary source of noise pickup, perform the following steps:

1. Turn off the vehicle's ignition switch.
2. Set the signal generator to produce 12dB SINAD at the receiver output.
3. Start the vehicle, and observe the SINAD reading. It should be degraded with noise from the vehicle.
4. Remove the antenna rod from the antenna mount and observe the SINAD reading.

If the SINAD reading returned to about 12dB, then the antenna is the source of noise pickup, and common-mode coupling is not a significant contributor to the problem. If the SINAD reading remains greater than 12dB, then common-mode coupling may be the problem. If you discover that common-mode coupling *is* the problem, installing ferrite chokes on the coax, near the receiver input, should significantly reduce the noise.

It takes three things to get many of these noise problems rectified ...

If common-mode coupling is *not* the problem, the next order of business is to trace the noise back to the source. This procedure can be tricky because the noise can have more than a single source. It can also *ride* on wiring and appear at many points in the vehicle, causing confusing readings on the test equipment. A spectrum analyzer can be used with a homemade probe or pickup coil to perform the trace. A coil, such as the one shown in Figure 3 on page 24, can be used.

An alternative is to use the receiver itself as a monitoring tool and the SINAD meter as an indicating device. (See Figure 4 above.) Here, the signal generator is coupled to the receiver input through a directional coupler and set to produce a greater-than-12dB SINAD reading at the receiver output (perhaps 18dB–20dB SINAD). Then, the probe or pickup coil is connected to the input of the directional coupler through a length of coax cable that will allow you to move the pickup coil around to various locations to locate the noise source. A step attenuator should be used between the pickup coil and the directional coupler to "home in" on the noise source.

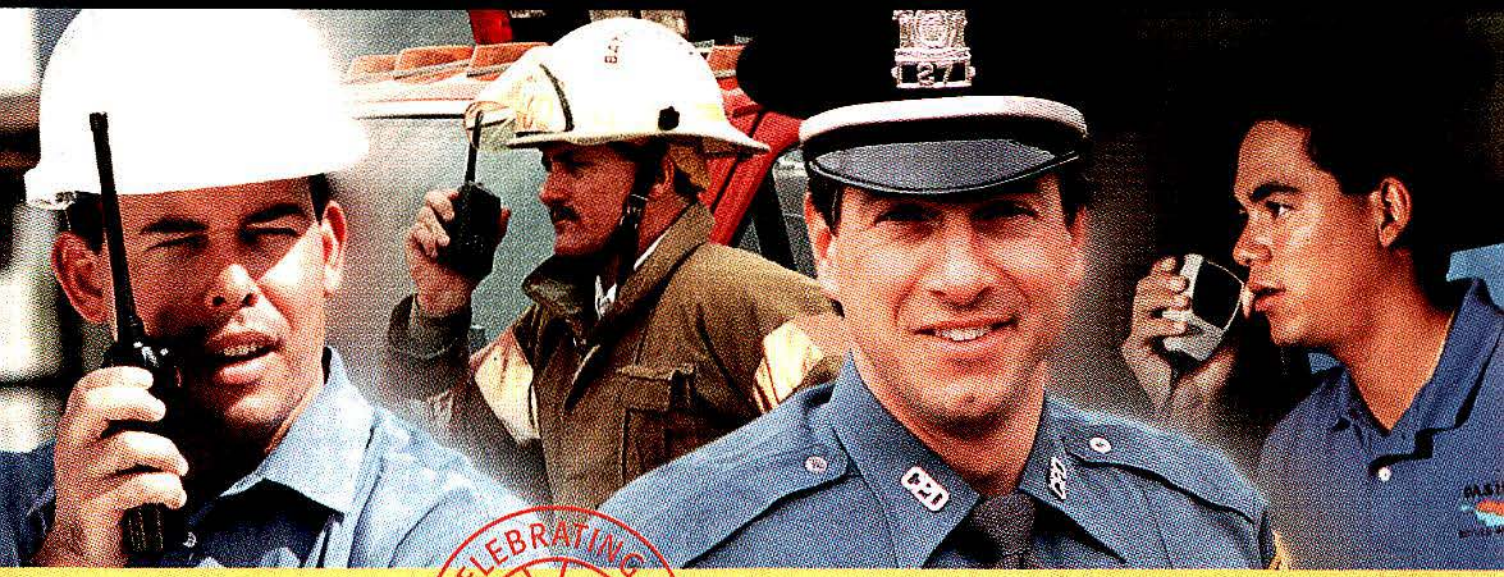
It is important that the coax itself does not become an antenna. Technically speaking, the only noise pickup should be through the probe or pickup coil. Well-shielded coax should be used to connect the pickup coil or probe to the directional coupler. It might be wise to use a ferrite choke on the coax near the input to the directional coupler to minimize common-mode coupling through the coax.

Once the noise source is pinpointed, the vehicle's manufacturer should be contacted for assistance. Often, a subcontractor is responsible for the manufacture of specific parts of the system, and direct contact with that vendor may be necessary. My experience is that it takes three things to get many of these noise problems rectified: persistence, persistence and persistence. These steps can be time-consuming, frustrating and not too profitable, if you're a commercial shop.

As far as the radio interfering with the proper operation of vehicle electronics, the onus is on *us*. If a customer is injured in an accident resulting from a malfunction of the vehicle electronics caused by interference from a mobile radio transmitter, who is likely to be held responsible? You guessed it.

Until next time—*stay tuned!* ■

All over the world, at every moment of the day, people rely on Kenwood Communications.



Celebrating 25 years of total quality commitment.

Kenwood Communications welcomes the new century by celebrating 25 years successfully maintaining vital government and industry communications throughout the world with quality two-way radio products and systems. Even though we're worldwide, we stay close to our customers with a network of authorized dealers and by consistently producing radios built to the strictest standards. As a company built on a commitment to quality, we make a simple promise to our customers as we enter this new century. We will continue to be the reliable, high performance choice in two-way radio communications. We know that our worth is measured by how we support our customers, with the products services you expect and deserve.

The Kenwood FreeTalk delivers quality in consumer personal communications.

KENWOOD

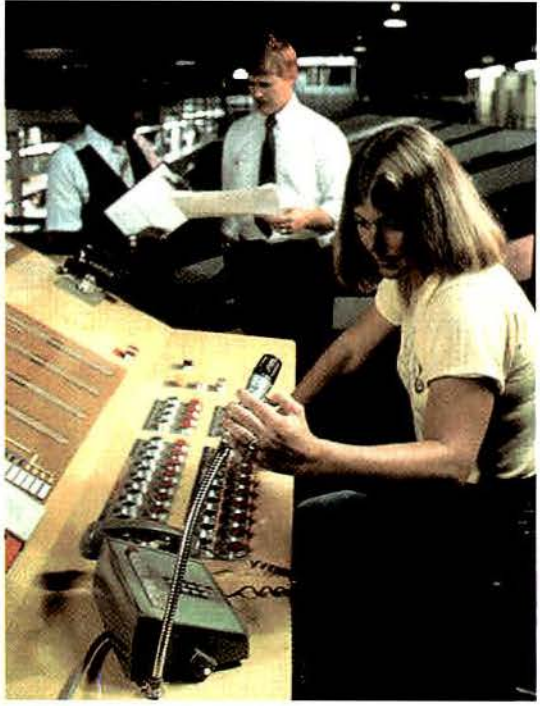
Always on duty.

1-800-950-5005 www.kenwood.net

Thank you for making this anniversary possible. Help us celebrate our 25th anniversary at IWCE in booth 101.

ISO 9001 JQA-1205

Circle (23) on Fast Fact Card



State-of-the-art radio facilitates UPS distribution

UPS gets a jump-start on new FCC directives.

By Thomas G. Dolan

According to the Industrial Telecommunications Association (ITA), the Atlanta-based United Parcel Service (UPS), through its UPS World Technology division in Mahwah, NJ, was one of the first large companies to take advantage of the FCC's "refarming"[1] efforts. This allowed UPS to get a jump-start in pushing its radio communications to new levels of efficiency.

The company's current state-of-the-art radio communications system wasn't developed overnight. The first FCC proposals on refarming were offered in the early 1990s. At that time, UPS already had a mature radio system in place, but, according to telecommunications manager Guy Hamblen of UPS Information Services, it was time to embrace even more modern radio technology.

"We followed the FCC announcements from the start. It was fairly clear that the agency intended to implement role changes in the use of the MRS [mobile radio service] spectrum, to introduce the migration to very efficient radios and to accommodate the needs of the existing user base to consolidate services—as well as improving the administration of the licensing system," Hamblen said.

"For UPS, the opportunities were very clear," Hamblen said. "We saw the chance to move from 'unprotected' to 'protected' frequencies, to simplify some of our internal business processes through centralized ordering and maintenance functioning, to reduce internal operating costs through a simplified radio infrastructure—which would mean more simplex operations and less repeater usage—and to open up trunking on frequencies at 800MHz–900MHz, which offered a distinct advantage to our larger facilities."

But all did not go smoothly for UPS in its drive to claim these opportunities. There were challenges to the new rulings, questions that had to be resolved by the user base. UPS was stalled in setting up its strategic plans because of four years of various FCC delays. "We had positioned ourself in 1996 to reform our entire base of about 6,000 users, but further delays took place, so it was not until mid-1997 that the FCC released its final order," Hamblen said.

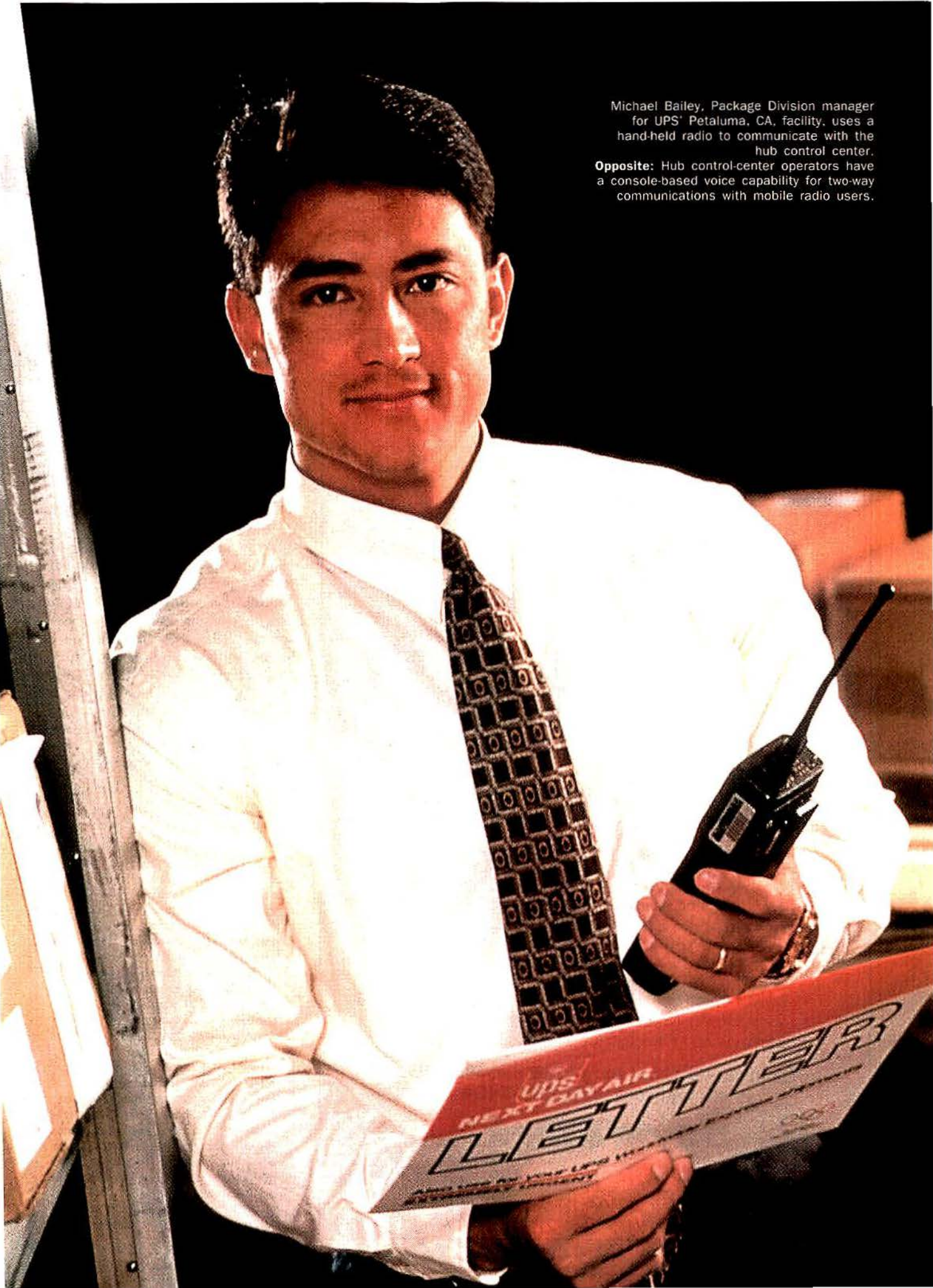
UPS requested ITA, which was the designated FCC coordinator, to finalize its plan and to be ready to process license applications as soon as it was allowed.

"Our goals were to acquire primary-channel frequency, greater output power, greater antenna height; to standardize as many of our frequencies nationwide as possible; as well as to standardize our equipment and develop frequency plans for each location to centralize maintenance, purchasing and administrative control in order to ensure FCC compliance requirements," Hamblen said.

Telecommunications manager Jim Pfannenstiel said that once UPS got the

[1]In 1997, the FCC adopted the Second Report and Order (Second R&O) in PR Docket No. 92-235, which consolidated the 20 Private Land Mobile Radio Services into two pools: Public Safety and Industrial/Business. The second R&O also introduced competition into frequency coordination services and created opportunities for implementing centralized trunking technology on channels in the shared frequency bands below 800MHz. Channel spacings were also changed to create new channels within existing spectrum by narrowbanding. The new rules became effective in October 1997.

Dolan is a freelance telecommunications writer.



Michael Bailey, Package Division manager for UPS' Petaluma, CA, facility, uses a hand-held radio to communicate with the hub control center.

Opposite: Hub control-center operators have a console-based voice capability for two-way communications with mobile radio users.

"green light" from the FCC, it surveyed its 1,700 operating facilities (hubs and centers) to verify whether they all *did* use radio.

More than 300 did use wireless, with varying degrees of radio sophistication. Some of the smaller facilities only required simplex channels. The largest installations, accounting for about 10% of the facilities, used repeaters to support radio communications.

Wireless @ Work

"We understood that as a result of this refarming, all of these frequencies would be designated as high-power frequencies, primary status," said Pfannenstiel. "So we reacted by applying for primary status of 12.5kHz [channels] for over 250 of our locations as well as for antennas up to 50 feet."

Pfannenstiel reported that the ITA was helpful with the refarming. ITA coached and counseled UPS not to attempt to refarm in some rural areas where it was not really needed. It supported the company in its main endeavors and conducted the appropriate tests to make sure that if UPS was granted its requests, there would not be interference with other users.

As a result of this refarming, UPS now has more 6,200 hand-held radios, and more than 500 mobile radios that are used to coordinate the location and positioning of the shipping trailers around the distribution grounds and air hubs. There are more than 160 control stations, about 80 of which serve as repeaters. In addition to the five operating trunking sites, UPS has plans for at least two more stations.

It was not until mid-1998 that the actual licensing began to take place. The process is now almost complete for the 250 locations requested for 12.5kHz channels, plus the transition to taller, 50-foot antennas.

So what types of job applications does this radio system support?

A few brief facts are in order: More than 326,000 UPS employees worldwide (291,500 in the United States; 35,000 international) transport more than three billion parcels and documents annually (daily volume reaches 12.4 million units). More than 500 aircraft, 157,000 vehicles and 1,700 facilities are part of the organized system that provide service in more than 200 countries and territories. UPS, with 1998 revenues

UPS: The early years

In 1907, America needed private messenger and delivery services. Few private homes had telephones, so personal messages had to be carried by hand. Luggage and packages also had to be delivered privately. The U.S. Postal Service would not begin the parcel post system for another six years.

To help meet this need, an enterprising 19-year-old, James "Jim" E. Casey, borrowed $100 from a friend and established the American Messenger Company in Seattle. With a handful of other teenagers, including his brother, George, Jim ran his service from a humble office. Despite stiff competition, the company did well, largely because of Jim Casey's strict policies: customer courtesy, reliability, round-the-clock service and low rates. These principles, which guide UPS even today, are summarized by Jim's slogan, "Best Service and Lowest Rates."

UPS' state-of-the-art radio technology is but the latest expression of this slogan.

The New Motorola Radio is Now Complete

VOICE PRIVACY

Call Now for Details
1-800-276-8878
or 402-474-4800

Visit us at IWCE, Booth #501.

TRANSCRYPT®
Crypto-Voice-Plus

Circle (25) on Fast Fact Card

pegged at $24.8 billion, is the world's largest package distribution company.

Keeping these statistics in mind, it is obviously a huge task simply to orchestrate the movements of the familiar brown tractor-trailer rigs as they load and off-load at the land and air hubs. But an even bigger task is expediting the processing of millions of packages per day.

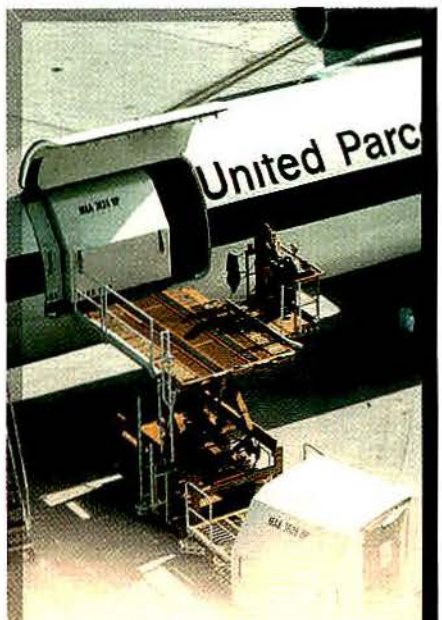
"Generally, the radio system is utilized for time-critical package operations; in most instances, broadcast by request," said Pfannenstiel.

Person-to-person communication is infrequent, Pfannenstiel said. If there were a snafu, typically, you would expect communications to be limited to the employee spotting it and the person calling it, rather than broadcasting the problem to everybody. In this case, the opposite is true.

"Suppose somebody downstream is not getting packages. He knows something is wrong but can't see the source. So he broadcasts to everybody in the facility, and everybody looks around to try to pinpoint the problem. Everybody is tuned to the same channel," Pfannenstiel explained.

This philosophy begins to answer the question: Why doesn't UPS use a commercial system?

"We're often asked why we don't use cellphones," Pfannenstiel said. "First, a cellphone doesn't have a broadcast capability. Second, it takes a long time to dial up a number and wait for someone to answer, as opposed to a push-to-talk radio. In short, especially doing a major sort, we need rapid and reliable communications."

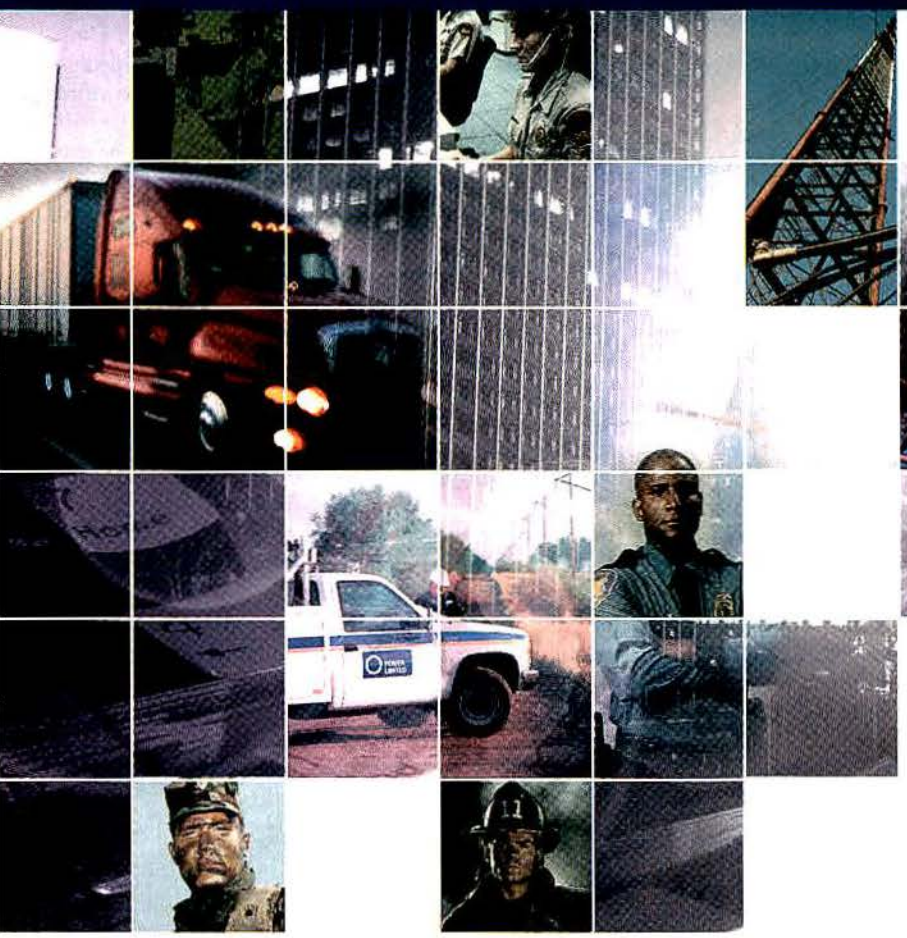


UPS Facts

Founded: Seattle, Aug. 29, 1907
World headquarters: Atlanta
Daily delivery volume: 3.14 billion packages and documents
Daily air delivery volume: 1.8 million packages and documents
Service area: More than 200 countries and territories (includes every U.S. address)
Employees: 326,800 worldwide (291,500 U.S.; 35,300 globally)
Customers: 1.61 million (shippers that receive automatic daily pickup service)
Operating facilities (hubs and centers): 1,713
Delivery fleet: 157,000 vehicles (package cars, vans, tractor-trailers)
Jet aircraft fleet: 224 total
Chartered aircraft: 302
Daily flight segments: 995 domestic; 559 international
Global telecommunications network: 100 countries and 900,000 users served
(Information based on worldwide facts presented at ***www.ups.com****)*

BANDWIDTH IS PRECIOUS...

Don't Waste Yours Using Outdated Technology!



Introducing INVADR™ Wireless IP Voice and Data Networking™

Increase the Value of Your Bandwidth

INVADR is an advanced communications solution that uniquely provides wireless IP voice and data networking capabilities, utilizing the Internet for the mobile dispatch market. Starting today, the radio dispatch operations of Utilities, Transportation, Government, Public Safety, SMRs, and others can utilize INVADR to optimize the capacity of their valuable bandwidth.

Best of all, INVADR is affordable! This plug-and-play system is both cost-effective and reliable as a primary communications system, as an overlay for expanded capacity or redundancy, or as an analog trunk replacement, all with a low cost of ownership!!!

INVADR

- **Provides Wireless Voice over IP**
- **Provides Wireless Internet Access**
- **Increases Effective Channel Bandwidth Up to Four (4) Times**
- **Lowers Hardware Investment**
- **Is Plug-and-Play for Easier Installation and Maintenance**
- **Lowers Cost of Ownership**

ElectroCom SYSTEMS

Networking in Motion™

Circle (27) on Fast Fact Card

Visit us at IWCE, Booth #442.

Contact Us Today for More Information About ElectroCom and INVADR!!! Dealer Inquiries Welcome!
Telephone: 800-348-1477 or 562-946-9493 Email: info@ecomsys.com Web: www.ecomsys.com

A ground team relies on communication with its hub control center to efficiently load a UPS plane. Hand-held radios are an integral resource for the procedure. *Photo courtesy of UPS.*

UPS cannot rely on commercial systems to address the demands of this operational necessity, he added.

After receiving the FCC licenses, UPS proceeded with standardizing equipment in all facilities and developing a central control. Frequency plans were put in place. A specialized database helped centralize purchasing.

"Our goal was to standardize what field people can order," said Pfannenstiel. "By requiring them to purchase through a central office, we prevent deviations."

UPS has relied on Radio Communication Systems, Louisville, KY, to build the equipment for all the facilities and to make sure that the frequency plans are properly programmed to meet FCC compliance codes. All of the hand-held equipment is sent to Radio Communication Systems for service, but fixed equipment is repaired by local outfits. "Our local affiliates are close by and can respond quickly," Pfannenstiel said.

Voice communications, incidentally, is no longer used in the delivery trucks. Data communications, which can provide automatic tracking of packages, is the more efficient technology. However, voice still has its place; email would hardly be the appropriate way to communicate in the hubbub of a distribution center, where people are more busy doing other things than to sit down and look at a screen.

Despite the long and arduous journey through the "refarmlands," UPS has benefitted from getting a jump-start on the new FCC directives.

"First and foremost, we've received primary frequency protection from any potential interference," Pfannenstiel said. "This is critical, for many of our packages have priority status and cannot be delayed. Secondly, distribution centers are big, noisy work areas. The voice/radio broadcast allows all of our workers to communicate instantly and cooperate to get the job done as efficiently as possible." ■

WHAT IS **SNAP**?

CONVENTIONAL TO TRUNKING, IN A SNAP. REALLY.

*ICOM's subscriber units are built to meet strict military (MIL SPEC) standards*1. All units feature a die-cast aluminum chassis. A smart choice!*

Basic LTR® trunking is only a SNAP away! Our unique UT-111 snap in module lets you upgrade an ICOM subscriber unit*2 to trunking in seconds. Need conventional again? It's still available, even with the UT-111 module snapped in. Carriers and dealers alike will find their business two-way has never been more flexible...or profitable!

SNAP FLASH TRUNKING™

Need more than basic LTR, either now or in the future? ICOM's new IC-F4TR*3 portable and IC-F420TR*4 mobile feature both basic LTR and PassPort® software programmed into FLASH memory. Operate basic LTR now, then upgrade to PassPort when you're ready...or just go straight to PassPort now! Both models are backwards compatible, so you can operate a mixed system of PassPort and LTR. Future enhancements are possible with the FLASH memory.

FLASH MEANS FLEXIBLE UPGRADES AND CUSTOMIZATIONS.

ICOM®
www.icomamerica.com

Call 425-450-6088 for free brochures or 425-454-8155 to speak with an ICOM representative

Visit us at IWCE, Booth #801.

WHAT IS **FLASH**?

*1 Meets MIL SPEC 810 C/D/E for shock/vibration
*2 Select models only. Contact your ICOM dealer or, contact ICOM directly for more information: 425-454-8155.
*3 This device has not been approved by the FCC. This device may not be sold or leased, or offered for sale or lease, until approval of the FCC has been obtained.
*4 Estimated availability: December 2000. Availability/model name subject to change without notice.

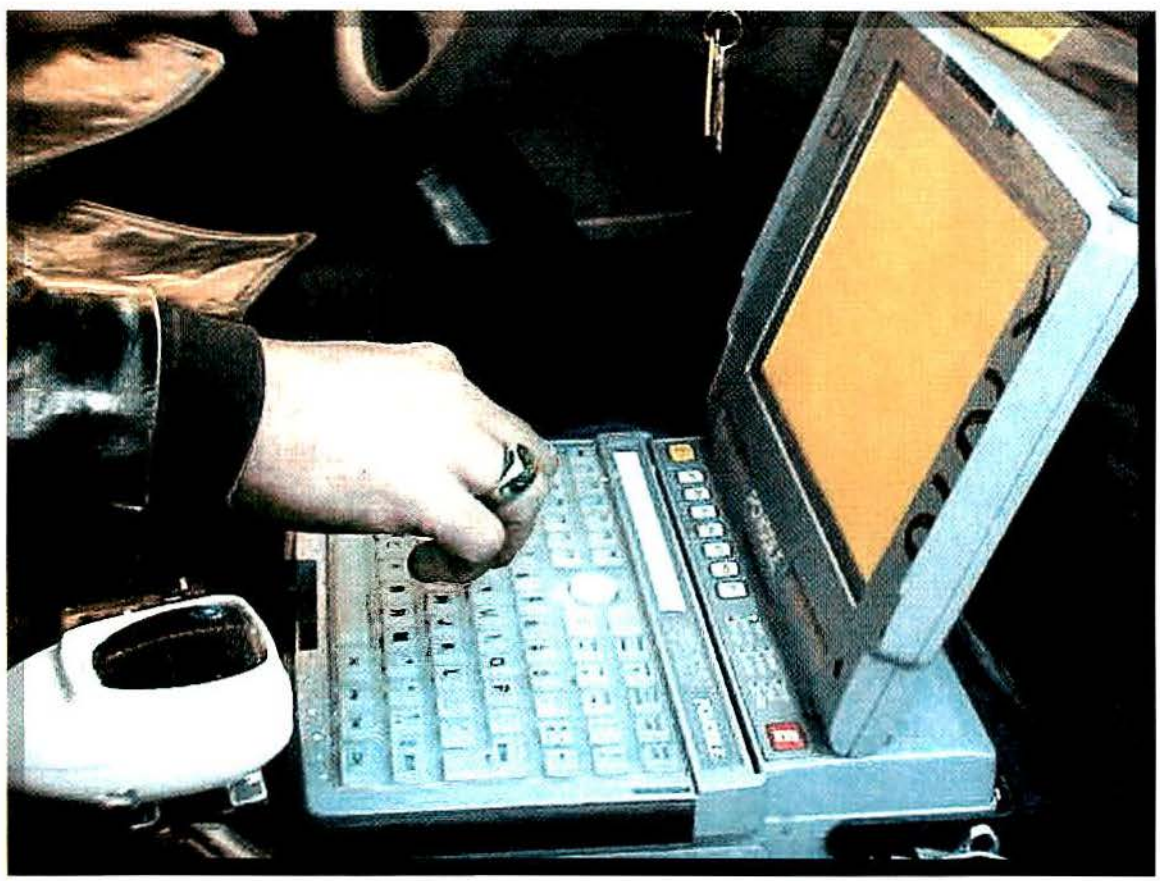
FOR PEOPLE WHO MAKE SMART CHOICES

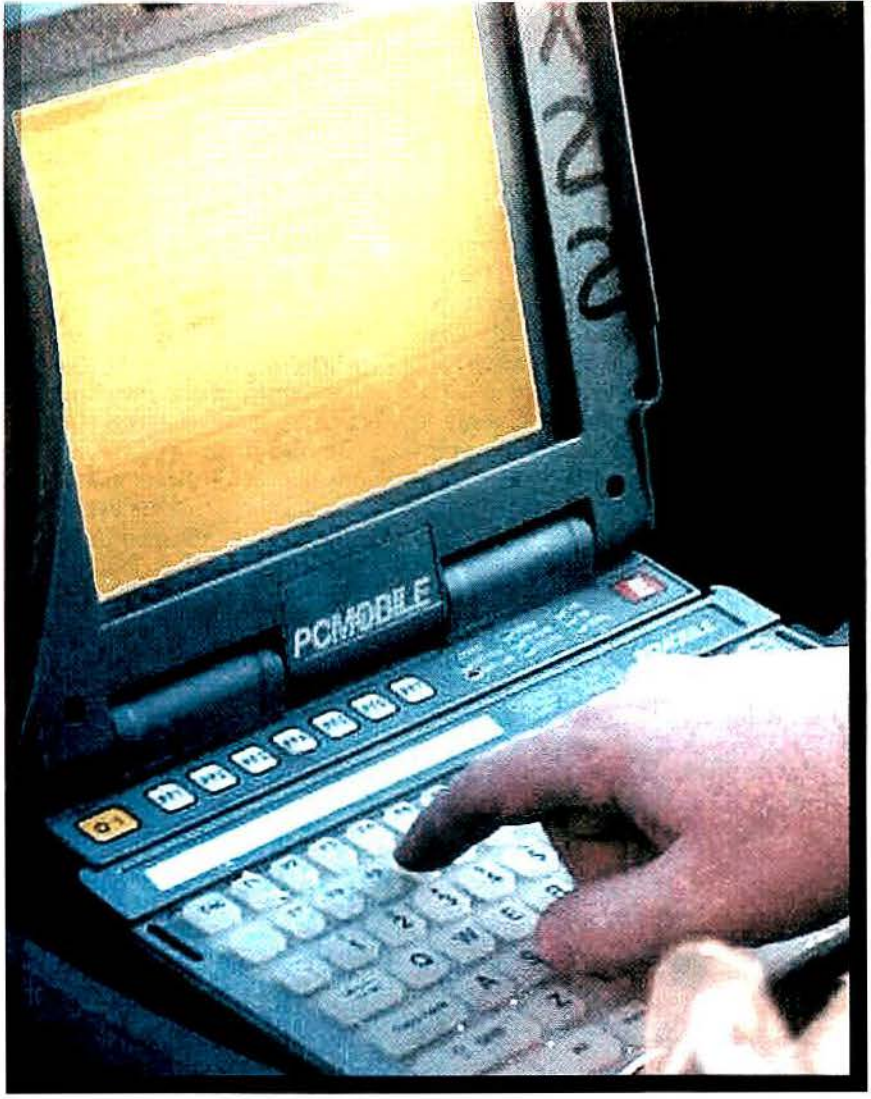
Circle (29) on Fast Fact Card

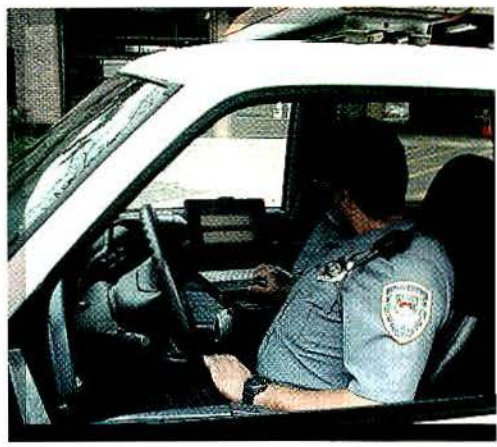
Putting MDCs on the beat

'Almost as important as their guns'

Expanding mobile communications to include CDPD gives police in three communities a resource to improve safety, efficiency and cooperation in real time.







Left and opposite: Mobile computing has allowed Philadelphia police to access criminal and vehicle records without burdening voice channels.

Above: Officer Jesse Camacho of the Altamonte Springs, FL, police works with 9-1-1 call data in real time, thanks to PC card enhancement of his MDC.

Public Safety

By Phoebe Yong

For decades, police agencies nationwide have depended on voice dispatch to maintain the lines of communication that are vital to doing their jobs. But, as communities and departments grow and the number of 9-1-1 calls escalates, officers are finding that voice frequencies do not answer all their needs.

This problem was evident in Philadelphia as early as 1994, when a congested voice system delayed response to the frantic 9-1-1 calls of several citizens who watched helplessly as a group of juveniles attacked young Eddie Polec with a baseball bat. Police officers didn't arrive until 45 minutes after the first 9-1-1 call. By then, Polec was dead.

Deputy Commissioner Charles Brennan, of the Philadelphia Police Department, Scientific and Technological Division, said he believed officers were available to answer the call on time, but the overcrowded voice channels had made it impossible to get Polec the assistance he needed.

"There were probably units available, but we couldn't get an assignment out because the radio was so clogged," Brennan said. "When one officer is talking to dispatch, other officers and dispatchers can't speak. It shuts them out. They have to sit and wait their turn."

Wait times can be particularly severe in major metropolitan areas. In Philadelphia, one dispatcher routed 30 or 40 vehicles using only a single pipeline. And, with more than three million 9-1-1 calls and one million field checks per year, it was evident to this agency that its once reliable voice system was no longer sufficient. The Polec incident brought the problem to the forefront.

Congestion afflicts all markets

Communications problems aren't limited to metropolitan areas. System overloads have victimized smaller communities such as West Jordan, a suburb of Salt Lake City, and

Yong is manager, marketing communications, of Sierra Wireless.

Sierra's Web site is **www.sierrawireless.com**.

Altamonte Springs, FL, which lies just west of Orlando.

West Jordan's police department is one of 53 agencies within the Wasatch District, which covers half the state of Utah. With the district's system of two-way radio dispatch through the Valley Emergency Communications Center (VECC), each agency found it difficult to distribute critical information across jurisdictions.

"We had no common radio frequency to communicate with each other," said Lt. Phil Bates. "We had no communication."

This lack of communication gave fugitives an easier channel of escape once they crossed a department's field of command.

Utah's problems didn't stop there. Over the past few years, the state's crime rate and 9-1-1 calls had been consistently on the rise. The overburdened airwaves could no longer handle the call volume, and police officers were experiencing delays getting needed information for vehicle and background checks.

"We've grown tremendously in population over the years, and there's only so much room for growth with radio spectrums," Bates said. "[Frequencies are] all issued out, so there's no way to obtain any more. We needed to find a new system of communication."

So did Altamonte Springs, which had gotten by for years with a single-channel, two-way radio. More than 40,000 residents make their homes in the city's 9.5 square miles, and another 25,000 commute there each day to work or shop. But, with a limited number of dispatchers handling the 50,000 9-1-1 calls and numerous field requests, the police department outgrew its single frequency.

But that wasn't all. The communications between officers and dispatchers were chaotic. Using the two-way radios, dispatchers would send the 9-1-1 calls to all officers in the field, giving them the chance to ask questions or to volunteer to take the call. Questions about addresses and case data caused severe delays, as officers asked dispatchers to repeat crucial information.

Likewise, non-emergency queries to the licensing database took nearly two minutes to complete because all the data were stored in one terminal. Furthermore, Altamonte Springs' unsecured voice channel opened up officer's communications to eavesdroppers, putting officers and victims at risk.

Getting backup from bits

Each of these precincts, big and small, realized it had outgrown its voice dispatch system and needed to find a modern communications alternative. The solution? Mobile computers featuring full-time wireless data access via modems.

Each system runs on cellular digital packet data (CDPD) networks, which relay packet-based data via circuit-switched cellular systems. Both Bell Atlantic Mobile and AT&T Wireless Services offer all-you-can-eat services in major metropolitan areas throughout the United States. Other carriers include GTE, Bell Mobility, MT&T, Comcast, Vanguard, SNET and SBC. Individuals, corporations and government agencies can subscribe to CDPD service, gaining a full-time connection to the Internet or to private networks with the same security protocols available for landline-based Internet services.

Each packet is transmitted independently and carries its own destination and error-correction information. Thus, packet networks perform well in systems with variable traffic and channel quality—common conditions in the wireless environment. Furthermore, service is available when the user is moving or in a fixed location.

Both the Philadelphia and Utah

You said, "I'm too busy to test and condition my radio batteries..."

...we listened - and made it fast, easy, affordable.

- One swipe of a bar code wand programs everything for the fastest, safest, most accurate battery maintenance system.
- Test and condition at least 33% more batteries per 8 hour shift with 2 Amps of programmable power per station.
- Eliminate battery damage from operator error with easy one-step bar code programming.
- Maintain Nickel and Lithium batteries – software upgrades manage future chemistries.
- No warranty return debates! Batteries tested to cell and pack manufacturers specifications.
- Test results displayed and reported on LCD and optional laser printer – no PC needed.
- Great Value: 30% - 50% below closest competitor. Save $500 -$10,000 (depending on system size).
- 5-Station System: $1425 - can do the work of 3 pieces of other non-programmable products.
- Networked expansion saves 20% for each added 5-station Bank.

- Less expensive battery adapters: at least 50% below closest competitor.
- BattTrack™ PC-based battery tracking software.
- Made in USA. Three-year warranty.
- Reseller programs available.

www.itecheng.com 800-233-6868, ext. 2102

iTech Intelligent Technologies

Circle (31) on Fast Fact Card

Visit us at IWCE, Booth #1070.

The Altamonte Springs P.D. has opted for PC (PCMCIA) cards for their MDCs that incorporate a GPS option to improve officer safety and increase response efficiency.

Police Departments adopted systems using Sierra Wireless' MP200 ruggedized, trunk-mounted modems. The MP200 is designed for high-power performance and is engineered to withstand vibration, extreme temperatures, ignition noise, humidity and physical shock.

Finding felons in Philly

The Philadelphia Police Department introduced the MP200 slowly, beginning with a pilot program that included 50 mobile data computers (MDCs) connected directly to the department's central data system via Bell Atlantic's CDPD network.

Less than 12 hours after the first MDC had been installed, the system began paying off. Two officers had observed a motorist behaving suspiciously, and one of them ran the license plate using the department's newest tool. Within seconds, the officers knew the car had been stolen.

"They were very excited and informed dispatch that they had a 'hit' on their MDC," Brennan said. "They pulled the car over. The driver tried to run, but the officers were able to chase him down."

The new MDCs allowed officers to access criminal and vehicle records through local databases as well as through the National Crime Information Center, freeing up the once-overburdened airwaves. The pilot program was such a success that the department soon expanded it and ordered 650 additional MP200s.

"A big plus with the MDCs is that the car-to-car messaging is secure," Brennan said.

"Many officers don't want to go on

MORE LESS?

yes

New Celwave Integrated-Technology Combiners.

Smaller Size, Lower Cost

What's light, compact, extremely versatile and perfect for the 851-869 MHz trunking band?

Radio Frequency Systems' new WIJD, LIWD and HIW Series integrated technology combiners, in three-, four-, five- and six-channel models.

Based on the operating characteristics and patented temperature-compensation technology of the previous WJD Series, these remarkable units are smaller ... lighter ... and easily expanded in the field.

Rigorously tested, our new combiners permit any channel arrangement and give you low insertion loss and high isolation between transmitters, even down to 150 kHz channel spacing.

Want more? These combiners excel in minimizing transmitter IM. And they are temperature-compensated to ± 0.45 ppm, with power dissipation up to 150 Watts, efficiently delivering your transmitter power to the antenna system.

In brief, Radio Frequency Systems' new integrated technology combiners bring you great performance in less space at lower cost.

Check them out. Call 1-877-RFS-WORLD to request free specification sheets.

And see how these remarkable units can boost the performance of your trunking system.

RADIO FREQUENCY SYSTEMS
CELWAVE® Cablewave

RFS

200 Pondview Drive, Meriden, CT 06450
Phone: 1-877-RFS-WORLD • www.rfsworld.com

Visit us at IWCE, Booth #933.

Circle (33) on Fast Fact Card

the street without wireless data communication anymore. To them, it's almost as important as their guns."

Up-to-date in Utah

West Jordan also saw the benefits of transmitting information securely, when the department chose CDPD services through AT&T. Another plus for the department was that transmissions are RSA-encrypted and Internet protocol-based, offering simple, secure access to local area networks (LANS) and Internet-based law enforcement databases.

West Jordan installed Toshiba laptop PCs, the MP200s and a Premier Mobile Data Terminal Talk-Thru RF server from Software Corporation of America. This newly installed system allowed officers to communicate information in real-time without going through the Valley Emergency Communications Center (VECC) or a headquarters server. Now, VECC dispatchers function as a backup information source instead of the constant liaison between officers. The dispatchers are free to focus their energies on the incoming 9-1-1 calls.

Following West Jordan's lead, other Utah police departments began installing wireless data systems. Currently, more than 300 vehicles from the South Jordan, Midvale, West Valley, Murray and Sandy Police Departments—along with the Salt Lake City Fire Department, Highway Patrol, DEA and Sheriff's Office—are using CDPD-based wireless data access. West Jordan maintains the email server for CDPD service.

"This system has created communications between departments that wasn't there before," Bates said. "We pass along 20,000 to 25,000 messages between that switch daily. Now, if we have a stolen car here, we can replicate the message to everyone."

The Utah Highway Patrol's tasks range from traffic enforcement to providing security for the governor's office. The department uses Sierra Wireless AirCard 210s, which offer multimode communicatios via a pair of PCMCIA cards that fit into adjacent Type II slots on laptop PCs. Troopers can submit time sheets and reports, as well as make on-the-spot background checks on suspects while they are on the road.

Speeding response at the Springs

Altamonte Springs also opted for the AirCard 210, which allows officers to read relevant data about each 9-1-1 call to assign themselves to the case in real time. Now, little time is wasted by having to repeat and confirm basic information.

With wireless data access, officers can expeditiously run checks from their vehicles. Officers can complete checks on stolen cars within three seconds, blistering speed compared to the two-minute wait for voice queries.

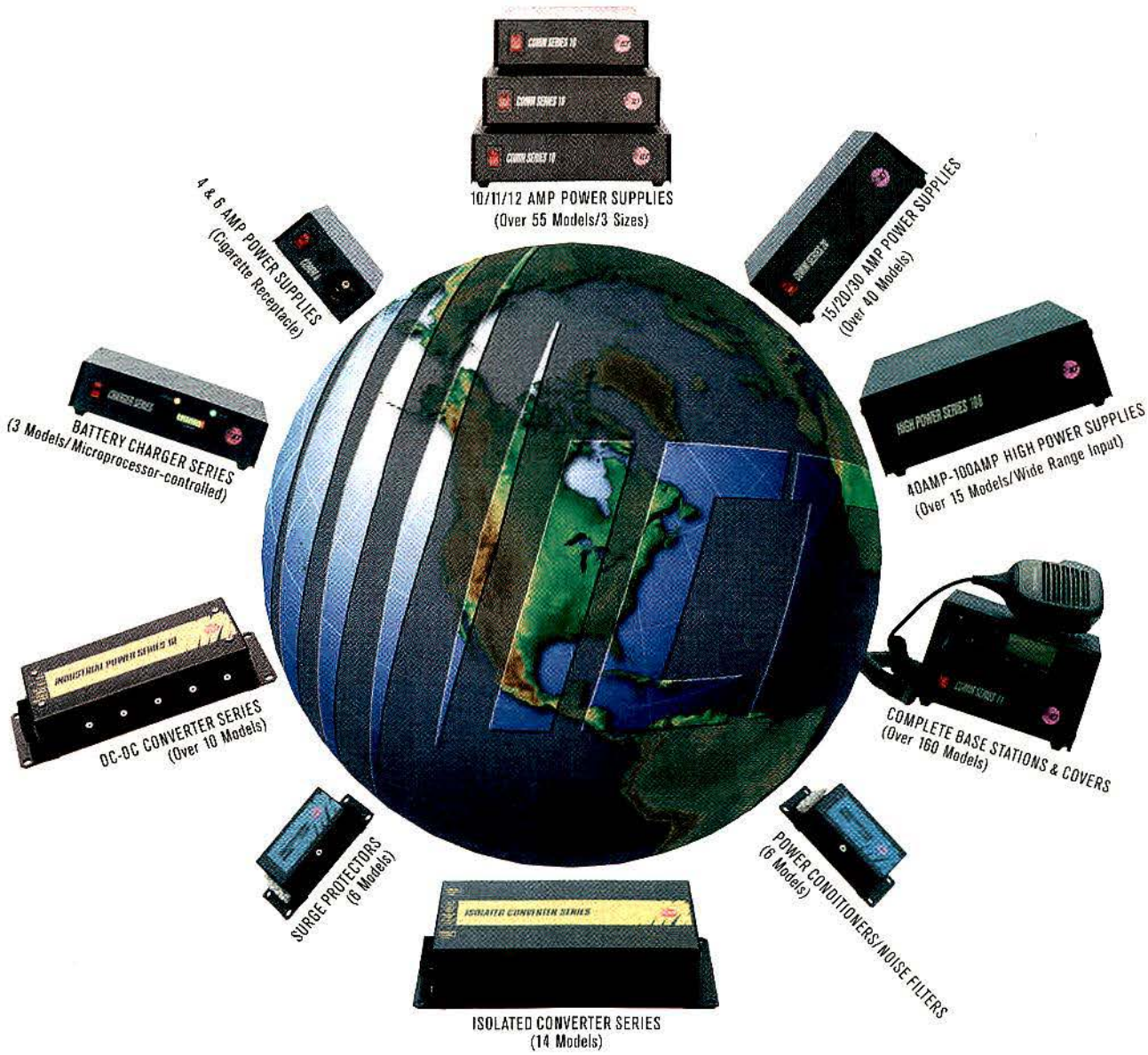
Altamonte Springs officers also enjoy the improved public and officer safety that the PCMCIA cards bring. Quick access to federal criminal databases allows officers to check plate information before approaching the vehicle, thereby increasing officer safety.

"The biggest benefit of this is that we are giving our officers the proper tools to do their jobs," said Lt. William Telkamp, watch commander, Community-oriented Police Services. "In return, we are achieving a higher standard for public safety and ensuring the safety of our officers is maximized."

It is this concern that persuaded Altamonte Springs to convert its system to MP200s with a global positioning system (GPS) option.

"We feel the MP200s with GPS will increase officer safety," said Telkamp. "If something happens that wasn't radioed in, we'll at least have a starting point of where to search." Telkamp also feels that response time to citizens' calls

Get the Power.



From the tours of the Grand Canyon, to the base camp of Mt. Everest, experience ICT's power of reliability. ICT Switching Power Conversion Products are unequaled in the industry for high performance and reliability. Over 300 products are available with output current ranges from 2.5 Amps to 100 Amps. We offer one of the largest selections of desktop switching power supplies, customized base station covers, wide range high power supplies, smart battery charger's, isolated and non-isolated DC-DC converters, noise filters and surge protectors. Installed in a grader, locomotive, dispatch center or repeater site, get the power of ICT reliability working for you.

Visit us at IWCE, Booth #1325.

The Power of Reliability

For great service, contact any of our distributors today.
Visit our web site at: http://www.ict-power.com or call: 604.888.6304

AF CommSupply / Allcan Electronic Dist. / Cartel Communication Systems Inc. / Electro-Comm Dist., Inc. / Graham Radio
Hutton Communications / Omni Eastcom Group / Omni Provincial Electronics Inc. / Primus Electronics Corp. / Pulstar Distributing, Inc.
Santa Fe Distributing, Inc. / Talley Communications Corp. / TEDI / TESSCO / WR Block & Assoc., Inc.

Circle (35) on Fast Fact Card

for help will be minimized.

"If a robbery happens at a certain place, the dispatcher can determine what officer is closer to the scene and assign it to that officer," Telkamp said. "We can also set up a perimeter easier to catch a suspect more efficiently."

Altamonte Springs plans to install the MP200s in 30 patrol vehicles and 10 motorcycles. The trunk-mounted devices will be placed in the motorcycles' saddlebags or in their equipment boxes, which already house the sirens.

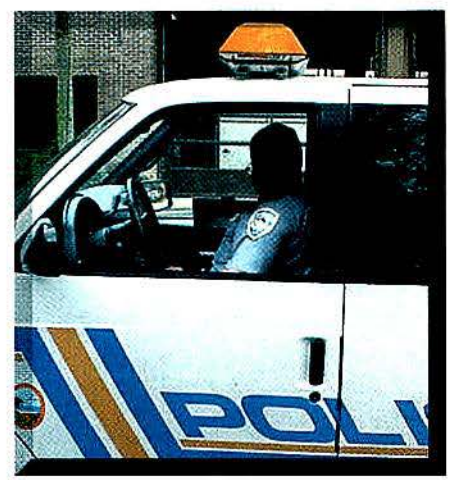
Efficiency and safety

In all three police departments, mobile data solutions have alleviated existing problems with voice communications. The systems arm officers with quick access to information, giving them a heads-up on the particulars of the person or vehicle sitting before them, while keeping voice communications free-and-clear.

"Our wireless communication solution has allowed us to become more resourceful, while increasing officer and public safety," Telkamp said. "We want to do more, do it faster and more efficiently."

Brennan is satisfied as well. "Our MP200s have proven to be almost flawless, and we are extremely happy with the product," Brennan said. "The system has been a home run for us."

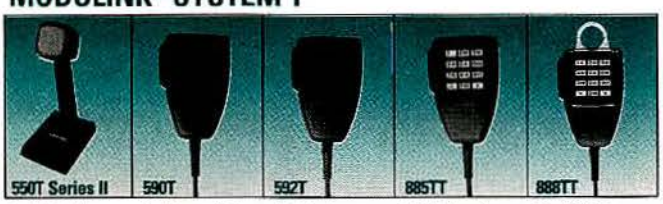
Police departments will have expanding requirements for flexibility of a self-contained Internet access device and the high-power and GPS options of PC cards. To meet these needs, Sierra Wireless has designed the AirCombo 350, which merges a Type II network interface card supporting Windows 95, 98 or NT with a vehicle-mounted power amplifier that increases the interface card's output power from 600mW to a full 3W. This system allows officers to access information from their laptop while inside or outside their vehicles. ■



ALL THE RIGHT CONNECTIONS.

Now compatible with Motorola MCS-2000 and Midland Bantam radios!

MODULINK® SYSTEM 1



550T Series II	590T	592T	885TT	888TT
Transistorized base station with split-bar monitor transmit switch	Transistor amplified dynamic	Electret condenser with noise-canceling pick-up	DTMF with continuous-tone dialing and illuminated keypad	Aircraft DTMF, noise-canceling and FAA certified

Shure ModuLink® handheld microphones connect easily to virtually all popular radio transceivers with no hardwiring. Simply snap the correct cordset into the Modulink microphone and the transceiver. And in just 30 seconds, you're ready to roll.

ModuLink® saves service time, reduces downtime and inventory costs, as well as all the quality you've come to expect from Shure.

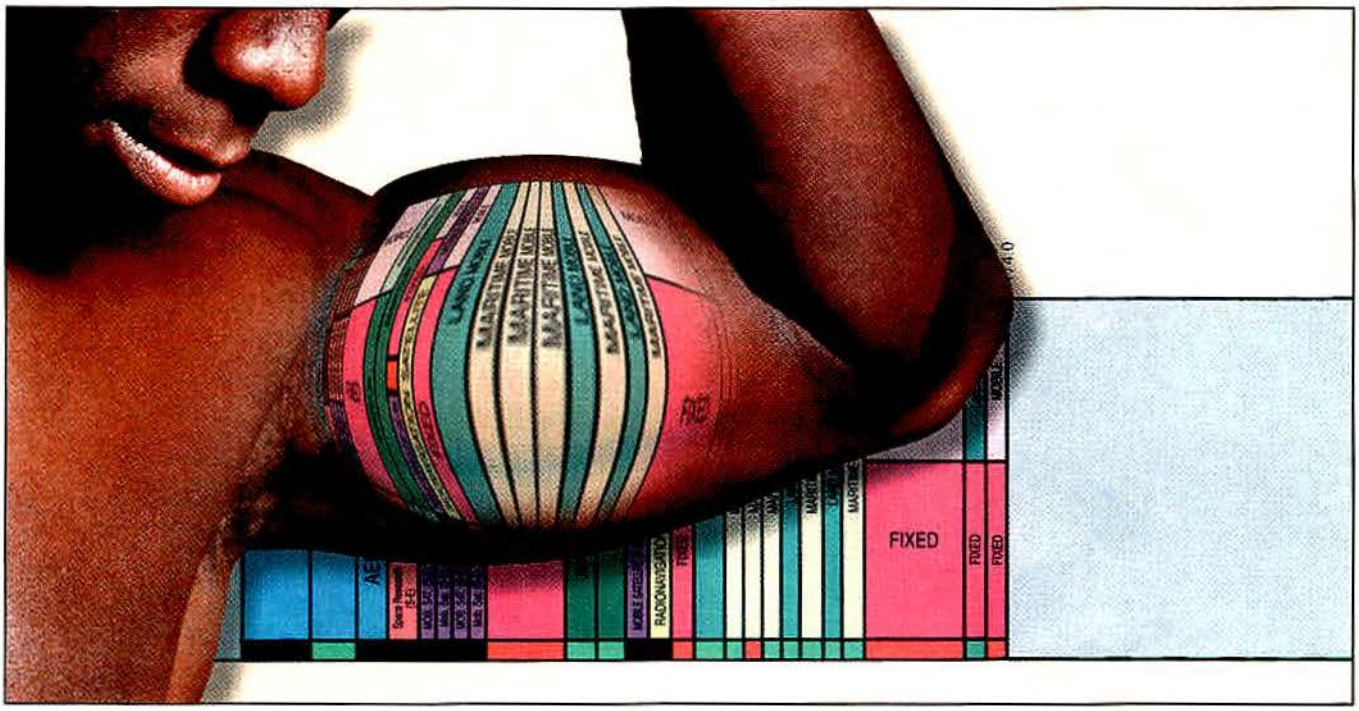
For more information on how you can make all the right connections with Shure ModuLink System 1, call 1-800-25-SHURE.

SHURE®

www.shure.com

Visit us at IWCE, Booth #1048.

Circle (38) on Fast Fact Card



VHF HIGHBAND: MOBILE RADIO'S MU

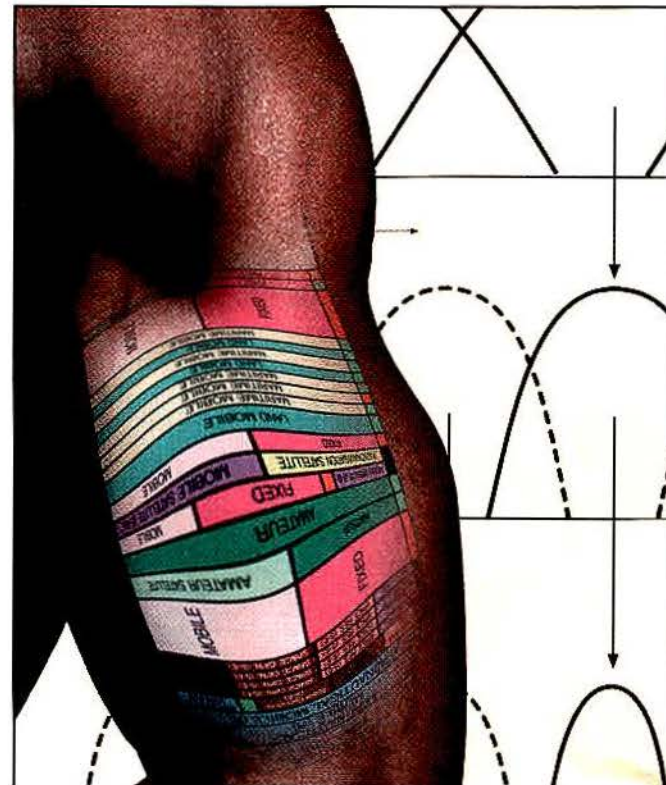
GHBAND: MOBILE RADIO'S MUSCLE

By David Keckler

Under the spreading F-C-C
The allocation stands;
The choice, a mighty frequency
For work and safety land;
And the coverage of its brawny waves
Makes strong this iron band.

As we poise on the advent of a new millennium, when all anyone wants to talk about is Internet Protocol, digital *anything* and communications "solutions," it's time for an ode to the last band standing.

It's not new. It's not sexy. Heck—it's still calling itself *radio* instead of wireless. The Quasimodo of telecommunications is VHF highband, hiding in the towers and doing all the work. *MRT* readers deal with more than a dozen different, high-profile, mobile communications bands, ranging from trunked SMR and ESMR at 800MHz and 900MHz to paging frequencies to UHF-TV to PCS. Despite their individual business and agency plans, the one band with which most of them



Keckler is features editor.

Out Here, Field-Proven Takes On A Certain Significance.

You can't always predict where your next job will take you, but there is something you can rely on: your Site Master™ from Anritsu. After years of being dropped, tossed and exposed to some of the harshest weather conditions imaginable, Site Master has proven to be the world's best selling cable and antenna analyzer.

Site Master delivers accurate, repeatable performance. A field replaceable NiMH battery. And a sleek, lightweight design that's not only easy to carry, it's extremely rugged. Site Master's user-friendly, menu-driven interface is easy to use and requires little or no training. And thanks to its ability to identify, record and solve a multitude of problems without sacrificing measurement accuracy, Site Master makes deployment, performance verification and maintenance a breeze, no matter where you are.

For more information call 1-800-ANRITSU or check out our website at www.global.anritsu.com. Site Master from Anritsu. The preferred choice among leading network operators and service providers worldwide.

Linking the World

Anritsu

Site Master

One world. One name. Anritsu.

Visit us at IWCE Booth #1249.

(over 80%) still dance is good ol' VHF highband.

Busting the bad boys

Several estimates still put three-quarters of law enforcement communications in VHF highband. (That would be about 1.2 million transmitters, give or take a base or two, using FCC licensing figures.) Most agencies have conventional analog systems, and although nearly half will replace and upgrade over the next 10 years, most will stay at VHF highband. Use of 800MHz and digital systems will probably double from their current rate of deployment; about 30% of agencies will be trunking by 2010. These changes, however, tend to take place in large agencies.

Despite high-profile, national efforts, a large majority of agencies prefer *local* interoperability planning, and most agencies still use VHF highband for interoperability with other law enforcement entities. Only about 5% of state and local law enforcement agencies employ 100 or more full-time sworn personnel. Granted, that small percentage accounts for two-thirds of people in blue—which is multitudinous mobiles and plentiful portables—but the remaining third scatters across 17,000 small departments (read: customers) from Key West to Nome. It's a substantial market, but the city council members and county commissioners are not going to pony up for sexy radio systems. (They're still paying the bills for Y2K and ADA compliance.) Highband users tend to be on a tight budget (or, people on tight budgets tend to be highband users—take your pick), and there are equipment and construction savings in single-site buildouts. These small agencies do not attract direct sales from Schaumburg, IL, Lynchburg, VA or Long Beach, CA. Their equipment will come from those places, but it will come through local dealers, and they know VHF highband.

Universal workhorse

Interoperability needs are not limited to law enforcement. Fire protection, EMS, and forestry services lean on VHF highband for that function as well. Likewise, VHF "high-life" has been the band of choice for auto emergency response, railroads, highway maintenance, taxicabs, utilities, manufacturing and energy production. These users are not on the band because the FCC said "Sit here." They use it because the radios work for the *jobs* they have to do.

The characteristics of VHF highband make it suitable to these professions. Two-way mobile radio operates in a small world—maybe one to 20 miles. For mobiles to keep in touch with base—and each other—transmitters have to have sufficient signal strength to cover that whole world. Propagation characteristics have to be suitable. Operating frequencies have to be in a part of the spectrum where antennas are efficient, omnidirectional and can be conveniently placed on masts, vehicles and portables (read: short). It has to be easy (and inexpensive) to generate adequate RF power. Vertical polarization is necessary to keep the radios robust and to gain a higher field strength near the ground. Short-range propagation also means the capability to assign the same frequency to a similar entity 50 clicks down the road.

VHF highband propagation characteristics are more suitable for affordable, wide-area coverage than higher frequencies. Antennas are short; range is good to excellent in urban and suburban locales; there is medium susceptibility to interference and foliage path loss is low. Okay, urban building fill-in coverage isn't so hot—but no band is perfect.

MASTER of MANY...

Public Safety

Our radio dispatch, E9-1-1 telephone, TDD, IRR, and fire alerting systems help police, fire, and emergency medical agencies save lives and protect property around the world.

Mobile Radio

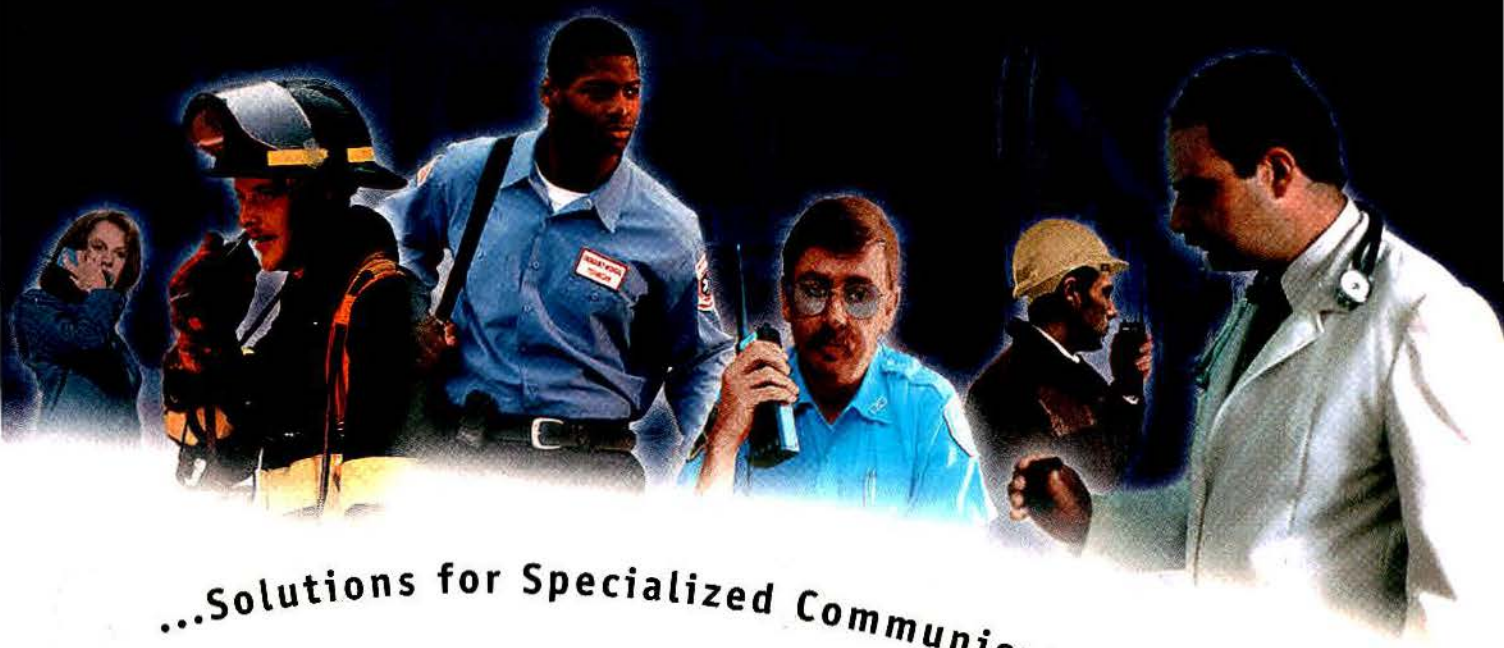
Customize a radio-telephone network for organizations such as utilities, healthcare, airports, campuses, and forestry that ensures complete control and security.

Paging Networks

Wide-area paging network for service providers and scalable on-site paging systems ensure a perfect fit for hospitals, hotels, casinos, and factories.

Wireless SCADA

As total systems or updates to multi-vendor systems, our Wireless SCADA, Telemetry, and Alarm Processors are ideal for waste/fresh water, oil/gas, and electric utilities.



...Solutions for Specialized Communications.

Zetron is a master when it comes to providing highly-reliable, easy-to-use, and reasonably-priced communications systems.

Many users in diversified applications recognize our commitment to quality products and superior service.

Small and large organizations around the world trust and respect Zetron. You can too!

Call today for your set of Zetron Product Guides.
Learn about solutions that support your business.

Circle (41) on Fast Fact Card

Visit us at IWCE Booth #715.

ZETRON, Inc.
Internet: http://www.zetron.com
Phone: 1-425-820-6363 Fax: 1-425-820-7031
PO Box 97004, Redmond, WA 98073-9704 USA
Email: zetron@zetron.com

European Office:
Phone: +44 1256 880663 Fax: +44 1256 880491
27-29 Campbell Court, Bramley, TADLEY,
Basingstoke, RG26 5EG, UK

ZETRON

Gilding the lily

Imperfect or not, there has been a lot of upgrading of VHF equipment in the last 50 years, but the old indulgent highband continues to accommodate us with each new twist. The post-World War II appearance of the transistor made mobile radio a reality by creating something you could more easily put in a vehicle. Integrated circuits 20 years later made it something you could wear. Modulation schemes keep changing. Amplitude-companded single-sideband for spectrum conservation was the rage 15 years ago; now add to that "linear modulation" (LM; which some may argue is essentially the same thing).

Radios got smaller, data baud rates got faster, trunking protocols were created, continuous tone-controlled and digitally controlled squelch systems were added. Filters have been improved, and receiver chains have been refined. Multimode radios became available, and there are more than a few competing technologies now for modulating signals and accessing channels.

The overriding concern, however, is not improving technology to make VHF highband work better; it's how to get *more* people on *less* of it.

The 'Incredible Shrinking Bandwidth'

After W.W.II, there was a brief, shining moment in the land of VHF highband, when channel spacing was 100kHz. Then, thanks to the previously mentioned refinements in radio equipment, everyone wanted to use it. Then for years channels were 30kHz wide and spacing shrank to 15kHz. In the 1980s, private user groups became advisory committees one morning to handle frequency assignments because the FCC had other. It was staging rehearsals for its refarming initiative (which has had nearly as long a run as "Cats").

Suddenly we were talking about 12.5kHz, 7.5kHz and (with LM) 5kHz channelization. "Thin" is "in." Federal agencies, like the FBI, INS and U.S. Marshals Service, must halve their bandwidth allocations for VHF by 2005, and federally regulated commercial entities are following suit. *MRT* will examine some band plans for narrowbanding VHF highband in the future.

And the band played on

Still, one 10-channel, trunked, narrowband repeater site is a lot of bang for the buck—so is a plain vanilla conventional system. Analog voice transmission techniques are still healthy. VHF highband may not get the publicity afforded other frequencies these days, but it's still out there every day, doing good work. If you operate it, say it loudly and proudly: "I ♥ VHF HB." ■

References

Bayly, Michael R. J., "Six into One Will Go," *Mobile Radio Technology,* January 1999.

Bishop, Don, "Radio Communications Improve Service on Forest Lands," *Mobile Radio Technology,* July 1996.

Kinley, Harold, "Using Crystal Filters at VHF Highband," *Mobile Radio Technology,* June 1998.

Parsons, J. D. *The Mobile Radio Propagation Channel,* Pentech Press, London, 1992.

Reaves, Brian A. and Andrew L. Goldberg, "Census of State and Local Law Enforcement Agencies, 1996," NCJ-164618, U.S. Department of Justice Office of Justice Programs, June 1998.

Shirley, Norman R. and J. Fred Cleveland, "VHF Highband Offers Narrowband Opportunities," *Mobile Radio Technology,* May 1987.

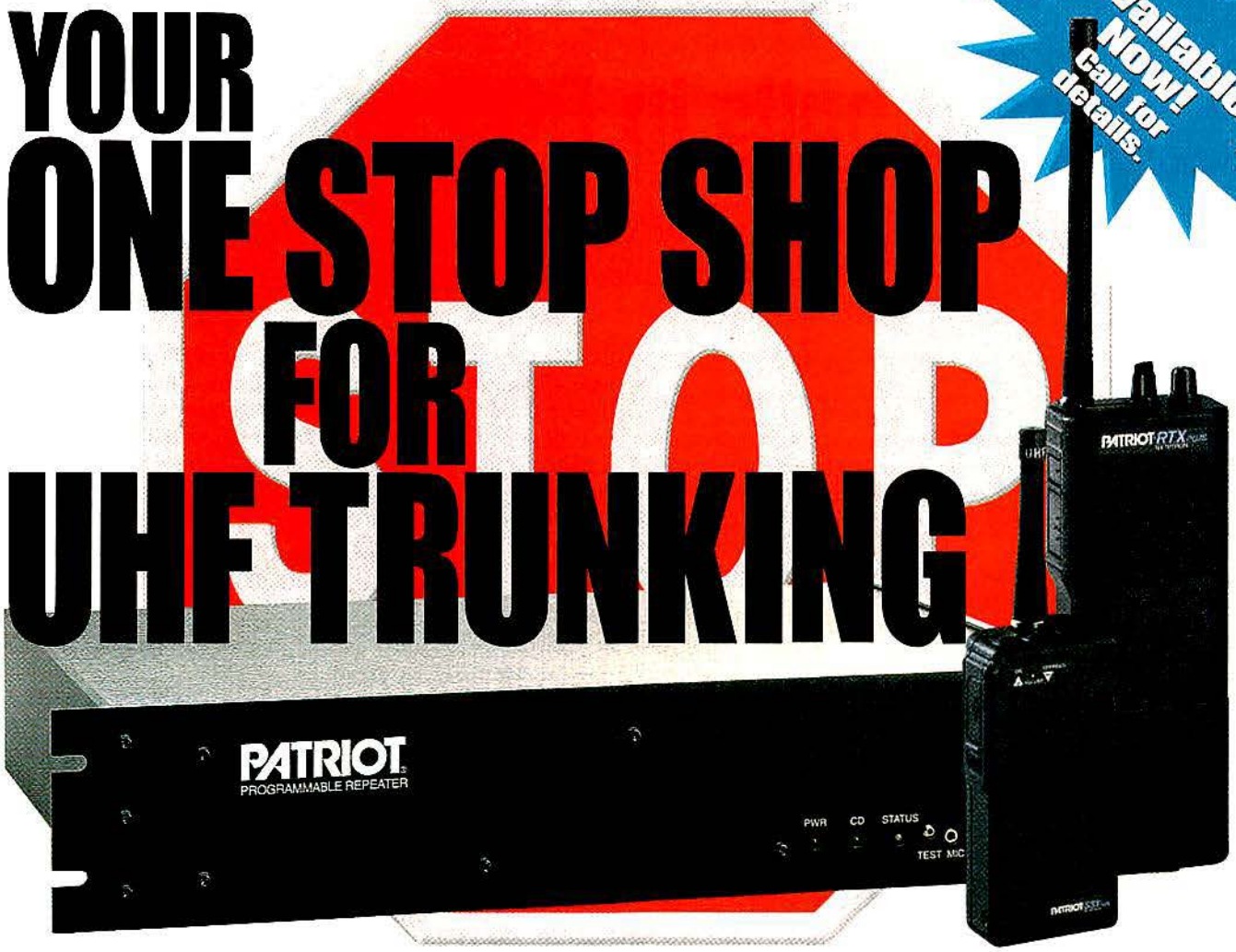
Singer, Edward, *Land Mobile Radio Systems,* Prentice Hall, Englewood Cliffs, NJ, 1989.

Taylor, Mary, R. C. Epper and Thomas K. Tolman. "Wireless Communications and Interoperability Among State and Local Law Enforcement Agencies," *NIJ Research in Brief,* January 1998.

Zhao, Yilin, *Vehicle Location and Navigation Systems,* Artech House, Boston, 1997.

YOUR ONE STOP SHOP FOR UHF TRUNKING

Available NOW! Call for details.



The Patriot Plus Series offers LTR and PassPort protocols

Ritrons' earned reputation for efficient, versatile, and affordable in-plant radio systems has evolved to give you an edge against obsolescence by featuring backward compatibility, interoperability, and the advantages of trunking. You can now offer your customers affordable in-plant trunking systems and wide area UHF trunking with the new The Patriot Plus Portable radios.

Patriot Plus radios are manufactured in the U.S.A., feature new firmware and high performance electronics, and provide enhanced user features and benefits. LTR and PassPort protocol capable; Electronic Serial Number, and unique radio ID code for automatic roaming between affiliated systems. Narrow and wide band models are available. Updates, enhancements, as well as custom applications, are easily accomplished by use of field reprogrammable FLASH microcontrollers.

Patriot SST Plus Portables are ultra small with flexible features and economically priced. PC Programmable-3/2/1 Watts, 4 channels/modes, Loud and clear audio output, Built-in Quiet Call and DQC signalling.

Patriot RTX Plus Portables are ruggedly designed for long operational life. PC Programmable-4/2 Watts, 11 channels/modes, Designed to meet MIL-STD 810 C&D (shock and vibration) specifications, Companded audio, Loud and clear audio output, Built-in Quiet Call, DQC and optional DTMF Encode Signalling.

Patriot RRX Programmable Repeaters are designed with high performance specifications and loaded with features at an affordable price. RRX Repeaters deliver exceptional intermodulation rejection, sensitivity, and selectivity specifications for trouble-free service. The RRX is also ideal as a trunking exciter.

If maintaining and increasing your market share is important to you... then don't stop. Call us today at **1-800-USA-1-USA** and **GO** with Patriot Plus by Ritron for all your trunking needs.

PATRIOT PLUS BY RITRON

Visit us at IWCE, Booth #1017 and 1225.

505 West Carmel Drive, Carmel, IN 46032, Phone 317-846-1201, FAX 317-846-4978 www.ritron.com

Circle (43) on Fast Fact Card

Filling nulls in PCS systems

Coverage extension and null fill in PCS systems can be accomplished with 8W CDMA bidirectional air-interface amplifiers.

By Bob Swinney

PCS carriers are tasked with providing transparent access to the world of modern communications. Users only see the handsets and are oblivious to the system technology and vast infrastructure required to furnish cost-effective coverage throughout the network. They want complete freedom to move about without annoying communications disruptions when they encounter RF shielded areas like buildings, tunnels, parking garages or terrain obstructions.

During the early days of PCS, a disturbing "rule of thumb" crept into communications system design procedures. This rule said three or four PCS cells are necessary to provide the same coverage as one 850MHz cell, a requirement that hinders providing cost-effective PCS service.

Today, bidirectional amplifiers (or repeaters), particularly the higher power models, solve PCS coverage problems without increasing the basic cell count, thus tossing the old rule. Before addressing application solutions, some general considerations influencing bidirectional amplifier systems design will be discussed.

System considerations

Bidirectional amplifiers (repeaters) in RF communications systems operate in much the same way as other transceiver elements. That is, they receive RF in one port and transmit RF on another port. Bidirectional amplifiers are really two amplifiers "turned" in opposite directions with their inputs and outputs combined and steered by directional elements, generally either circulators or diplexer filters. (See Figure 1 below.)

Range estimation

The goal of a bidirectional amplifier is to adjust RF power toward a target area that is otherwise not served by the base station. Bidirectional, of course, means RF in both the transmit and the receive directions is processed by the amplifier. The two routes (really the same route) are typically known as the *downlink* and the *uplink*. Downlink signals move from the base station to a mobile (or portable), and uplink signals move from mobile to base. Propagation characteristics of the path in both directions are of interest. A bidirectional amplifier, or repeater, assists in shaping coverage to fit specific nulls within the service area of a base station.

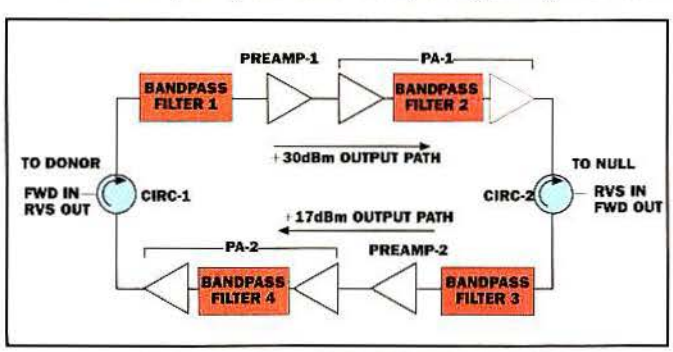


Figure 1. Block diagram of a typical bidirectional amplifier.

Basic propagation is described by the free-space loss equation:

$$\text{Loss}_{dB} = 32.3 + 20\log D + 20\log F$$

where

D = distance (in miles)

F = frequency (in megahertz).

This equation can be used to predict range under free-space conditions (that is, line-of-sight without multipathing). For example, how much signal could be expected from 10W effective radiated power (ERP) over a distance of five miles at a PCS frequency of 1,900MHz? Substituting these values into the free-space loss equation yields a free-space loss of 112 dB. The 10W ERP expressed in decibels above 1mW (dBm) is a transmit level of +40dBm. The +40 dBm transmitted signal undergoes a 112dB loss over the path to the distant end. Determining receive level is then a matter of adding gains and losses over the path. Considering a receive antenna gain of 15dB with receive line and multicoupler losses of perhaps 5dB, the transmitted signal would reach the far end with a level of −62dBm. The arithmetic is:

+40dBm (ERP) − 112dB (FSL) + 15dB (Ant. gain) − 5dB (line) = −62dBm

Similarly, on the uplink side, assuming a portable transmit level of 600mW (+27dBm), 6dB of portable antenna loss, the same path loss of 112dB, and line and multicoupler losses of 5dB, a signal of −80 dBm reaches the base station receiver. This implies the system is "talkback limited," or unbalanced, from forward link to reverse link, by about 18dB. In this example, a bidirectional amplifier with adjustable gain would achieve parity between downlink and uplink. In general, null fill projects require bidirectional amplifiers.

By definition, "free space" assumes that there is a line-of-sight path between the transmitter and the receiver. But, because of tower height and terrain considerations, free-space path conditions may not exist. A test equation that can be used to estimate the differentiation between free space and other propagation models is:

$$d = (2.3\times10^{-6})F(H_T H_R)$$

where

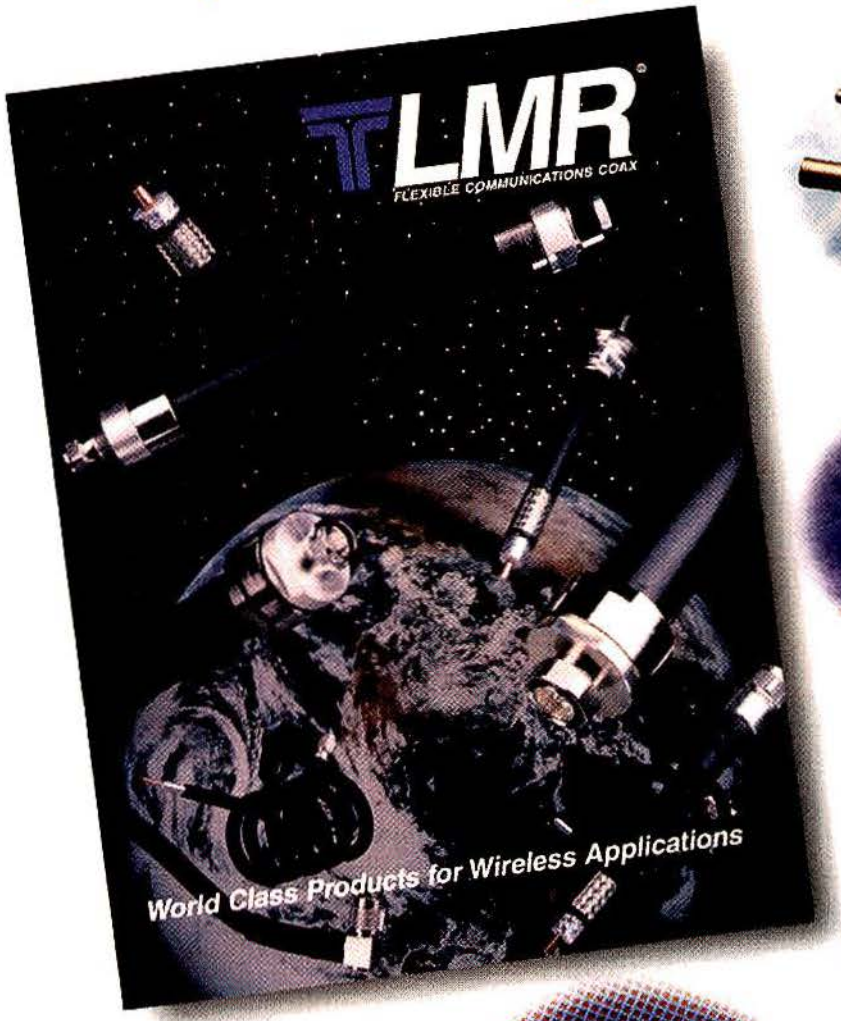
Swinney is an applications engineer for the Andrew RF Amplifier Group in Dallas. He can be reached through email at **bob.swinney@andrew.com**. This article is a revised and updated version of an article that originally appeared in *MRT's* companion publication, *Site Management & Technology*, in the Spring 1999 issue.

TIMES MICROWAVE SYSTEMS

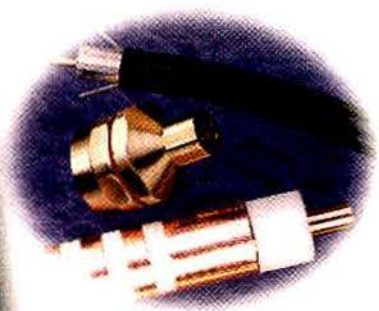
Distributed by PRIMUS ELECTRONICS CORPORATION

IWCE Booth #874

Flexible Coax Solutions . . . They're All Right Here



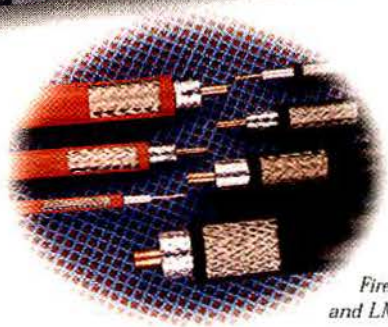
LMR® - DB Flexible Watertight Coaxial Cables



nu-TRAC® and Nu-RAD Radiating Cables

A Complete Family of Hardware Accessories and Installation Tools

A Comprehensive Line of Connectors



Fire-Retardant LMR® - LLPL Plenum and LMR® - FR Riser Coaxial Cables

A Full Line of Coaxial Cables, Connectors, Hardware Accessories and Tools.
For Times Microwave Systems updates please visit Primus Electronics at
www.primuselectronics.com

PRIMUS ELECTRONICS CORPORATION

18424 Northwest Frontage Road • Joliet, IL 60431 • 800-435-1636 • (IL) 800-892-1413 • Fax: 800-767-7605

For Information on Primus: Circle (86) on Fast Fact Card
For Information on Times Microwave: Circle (44) on Fast Fact Card

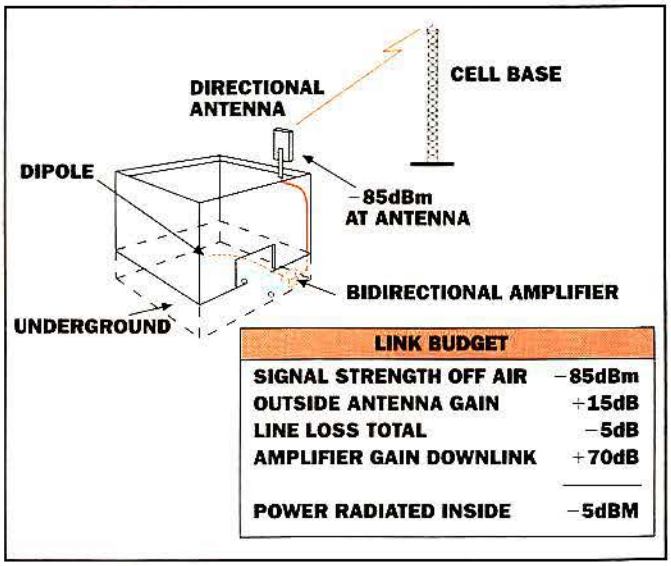


Figure 2. Typical system gains and losses.

d = distance (in miles)
F = frequency (in megahertz)
H_T = transmitting antenna height (in feet)
H_R = receiving antenna height (in feet).

When the path distance is less than d, free-space propagation is used. When the path distance is greater than d, another propagation model is used.

Many propagation models are in use today; most of them are parts of range-prediction programs. The Egli model is a straightforward manual method of predicting overall propagation loss over gently rolling terrain with average hill heights of about 50 feet. The Egli model is expressed as:

$$A_E = 117 + 40\log D + 20\log F - 20\log(H_T H_R)$$

where
A_E = path attenuation (in decibels)
D = distance (in miles)
F = frequency (in megahertz)
H_T = transmitting antenna height (in feet)
H_R = receiving antenna height (in feet).

A fill-estimation formula giving estimated RF coverage of dipole antennas can be derived from the free space loss equation. When antenna gain referenced to a dipole and line loss, amplifier gain, internal loss, available off-air signal strength and receiver sensitivity are taken in account, the derived formula becomes:

$$D_{feet} = \log^{-1}\left[\frac{(S + A + G - (-\text{Sens.}) - X - L - 32.3 - 20\log F)}{20}\right] \times 5280$$

where
D = distance between the dipole antenna and receiver
S = signal strength at the outside antenna (in dBm)
A = outside antenna gain (in decibels)
G = amplifier gain (in decibels)
Sens. = receiver sensitivity (in dBm)
X = line loss (in decibels)
L = inside absorption losses from walls, furniture, etc. (in dB)
F = frequency (in megahertz).

To obtain coverage in square feet, square the result and multiply by pi (π).

Figure 2 above left shows typical system gains and losses and how these values are used in the adapted free-space loss equation. In this example, an off-air pickup antenna and

GO ON, DRAG OUR REPUTATION THROUGH THE MUD.

	Racal 25	Competitor A	Competitor B	Competitor C
Volume (cu. in.)	**19.1**	23.9	29.9	40.1
Weight (ounces)	**16**	25	27	28
Power (watts)	**5**	5	5	5
Channels	**256**	255	255	256

	Racal 25	Competitor A	Competitor B	Competitor C
Metal Case	**Yes**	No	No	No
Submersible	**2 Meters**	No	No	No
Keypad Programming	**Yes**	No	No	Yes
Battery Meter	**Yes**	No	No	No

PROJECT 25 RADIO

Sure, it's the smallest, lightest radio to meet APCO Project 25 standards. But the Racal 25 digital portable is one tough little unit. And no wonder. Our reputation for rugged packaging of highly refined communications technology is unequaled throughout the military world. So the Racal 25 will impress you with features like full digital/analog interoperability. Advanced encryption and covert modes. Keypad and radio-to-radio programming. And extensive user-customization capabilities. But it's a rough, wet and dirty world out there. So be sure you get a Project 25 radio that can really take the abuse. Talk to us. *Communicating through technology*

Visit us at IWCE, Booth #1149.

Racal Communications, Inc., 5 Research Place, Rockville, MD 20850 www.racalcomm.com 1-800-258-4420

RACAL

Federal agencies can order Racal 25 on Department of the Interior Narrowband Radio Contract #N660-C98-1007.

Circle (46) on Fast Fact Card

bidirectional amplifier feed a single-point antenna in a building's parking garage within the sector coverage of a PCS cell site. The goal is to fill the parking garage null, which is beneath the building. Atop the building is in a −85 dBm signal strength contour. Substituting appropriate values into the formula, we have:

$$D_{feet} = \log^{-1}\left[\frac{(-85+15+70-(-95)-5-12-32.3-20\log 1900)}{20}\right]\times 5280 = 536$$

where
D = distance between inside dipole antenna and receiver
S = −85dBm outside signal strength on the roof
A = 15dB off-air antenna gain
G = 70dB bidirectional amplifier downlink gain
Sens. = −95 dBm receiver sensitivity of mobile unit
X = 5dB total line loss
L = 12dB interior absorption losses
F = 1,900MHz.

Figure 2 shows that estimated coverage is approximately 536 feet, or 903,000 square feet, around a dipole antenna in the interior of the null target area. (A dipole is shown for example purposes only. Radiating coaxial cable is recommended for efficient distribution of null-fill RF.) Variables in the "fill estimation" formula should be qualified as much as possible by measurement before using them to predict coverage. The formula considers only line-of-sight propagation and neglects multipath and other variants. Multipath can enhance or degrade performance, depending on conditions. Also, the absorption qualities of walls, furniture and other objects should be evaluated. The formula assigns a value of 12dB (L) as an estimated amount of absorption loss. Some texts assign an L value of 20dB or more, depending on the texture of the interior space to be filled. Preferably, absorption loss in a sample of the null target should be measured, giving a "dB/foot" density quantity for use in the formula.

The partial downlink budget shown in Figure 2 is built with some of the terms used in the coverage formula. A similar uplink budget can be calculated all the way back to the base station receiver. More link budgets will be included in the amplifier system design examples.

Composite power

"RF power" generally refers to composite power, the total average power in the envelope. Assuming all carriers are of equal power in a RF envelope, composite power is described as:

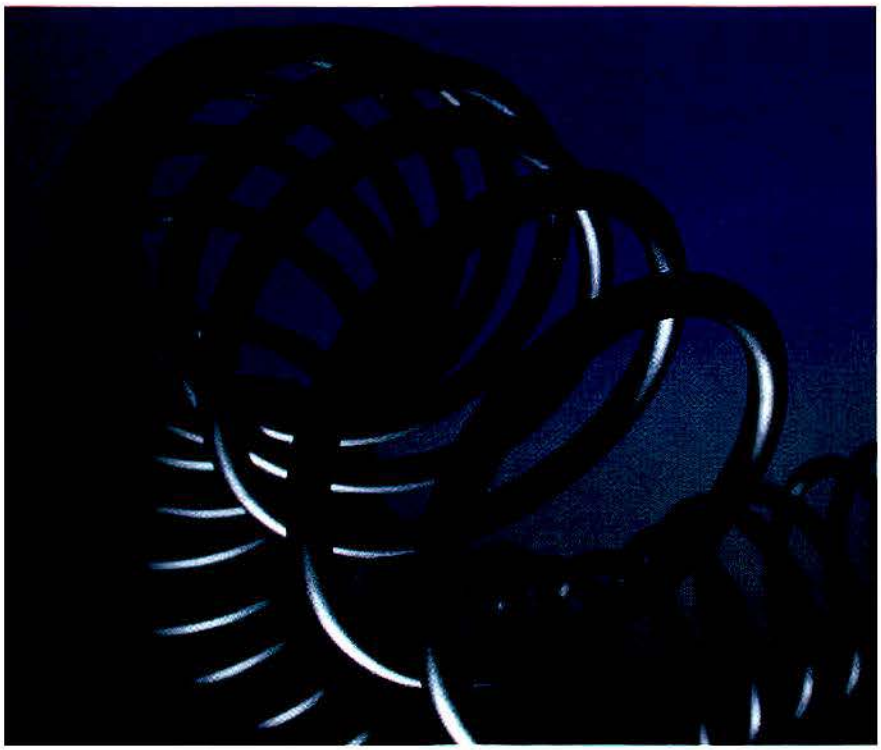
$$\text{CompositePower}_{dB} = \text{CarrierPower} + (10\log(n))$$

where
n = number of carriers and power is in decibels.

For example, in the formula above, 16 carriers (or channels) of 8W (39dBm) each represents a composite power of 126W (51dBm). Or, a 10W (40dBm) amplifier is delivering its rated power out over eight channels if the power in each individual channel is 1.3W (31 dBm).

Isolation concerns

Isolation between an air-interface antenna and a null-fill (repeating) antenna should be at least 10dB greater than system gain, as shown in Figure 3 on page 58. This 10dB of isolation is the minimum amount necessary to ensure system stability. Sufficient isolation is usually not a problem because isolation is an inherent quantity in a null-filling application. Thus, the same obstruction losses that must be overcome to "fill" the target area are usually more than enough to meet the



LOOKING FOR A FLEXIBLE COAX CABLE?

Come See Us Flex at IWCE Booth 1101

- Same CommScope quality
- Same CommScope reliability
- Same CommScope service
- Best CommScope value

6519 CommScope Road
P.O. Box 199 Catawba, NC 28609-0199
888-235-5732 (Cell Reach)
Fax 828-241-6022

www.commscope.com wireless@commscope.com

CommScope®
How Intelligence Travels.®

Circle (48) on Fast Fact Card

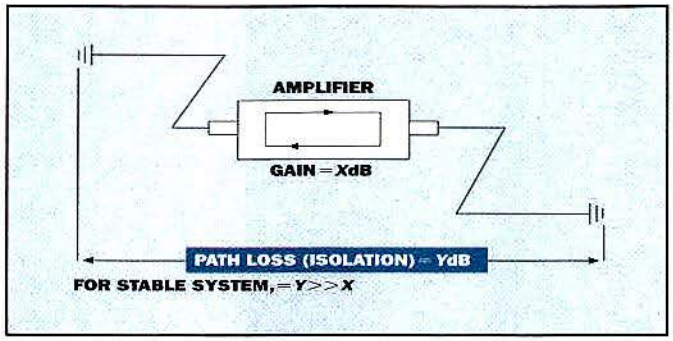


Figure 3. Minimum isolation required for system.

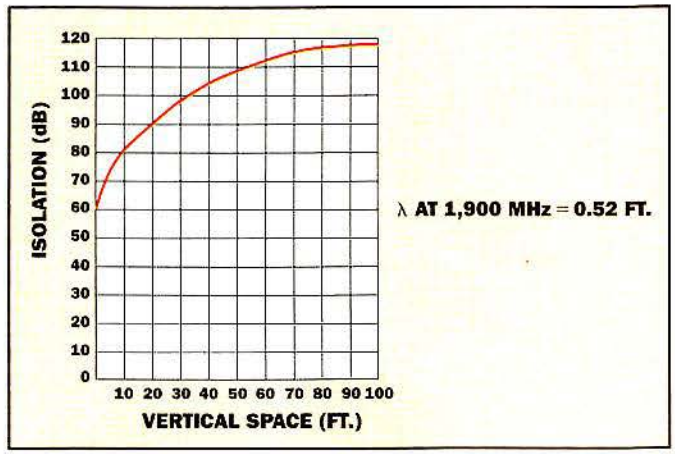


Figure 4. Vertical antenna isolation at 1,900MHz.

10dB isolation requirement. Antenna performance can provide additional isolation. The front-to-back ratio is a standard directional antenna term describing the ratio, in decibels, of forward-radiated power over power radiated off the back side of an antenna. Front-to-back ratios of 15dB–25dB are fairly common among directional antennas. Additional horizontal isolation can be obtained by taking advantage of structural or topographic features, such as penthouses or hills.

When directional antennas are mounted collinearly (one directly above the other), isolation is greatly enhanced by vertical separation. Vertically polarized antennas have pattern nulls off their ends. Fortunately, at cellular and PCS frequencies, the deep end nulls of directional antennas can be used to achieve additional isolation.

The vertical antenna isolation graph in Figure 4, above right, is based on the equation:

$$\text{Isolation}_{DB} = 28 + 40\log\frac{S_V}{\lambda}$$

where
SV = vertical separation between antenna radiating centers
λ = wavelength (same units).

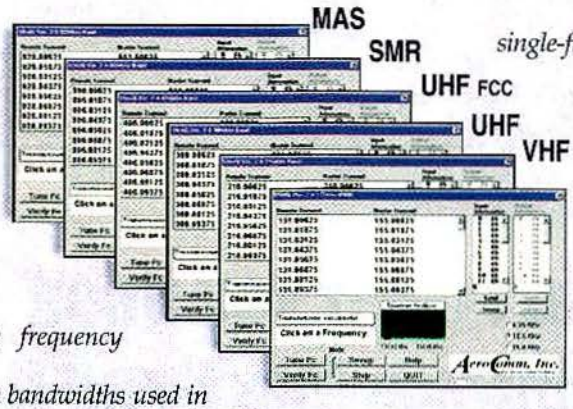
Output power and intermodulation

The output power of a bidirectional amplifier is formally expressed in terms of its 1dB compression point, which is the output power at which gain has dropped 1dB from where it would have been in a totally linear system. Intermodulation (IM) worsens with increasing levels of overdrive. The projected amount of IM can be calculated by using the amplifier's 1dB compression point and output signal power levels.

In general, bidirectional amplifiers are operated in a manner that keeps the composite power output well below the 1dB

Having the right choice for the right application is always key.

Ultra-Q is the right choice for solving your interference problems...and is now available at VHF, UHF, Cellular, and PCS frequency bands.



Applications within these frequency bands coincide with the narrow bandwidths used in two-way communications for voice and data.

Bandwidths are available matching the receiver bandwidths of 25 KHz, 12.5 KHz and 6.25 KHz.

Ultra-Q eliminates the need for bulky and multiple single-frequency band stop filters as it is a frequency agile bandpass filter with an extremely high Q.

Similar to the original Ultra Q designed for MAS applications, gain – along with narrow band filtering – is provided via this modern programmable active low-noise filter.

Custom designs are available upon request. For more details, contact us via the information below.

It's the choice of filter that's always up to par.

Circle (50) on Fast Fact Card

Ultra-Q Active Bandpass Filter

AERO COMM

A Wireless Systems Company

560 Sylvan Ave. 3rd Fl.,
Englewood Cliffs, NJ 07632
Phone 201-227-0066 / Fax 201-227-0067
E-mail mail@aerocomminc.com
Web www.aerocomminc.com

compression point. This is done to minimize IM products. Be careful to ensure that the input composite power is not capable of overdriving the amplifier. Input power levels must be accounted for in accordance with the "10log(# of carriers)" rule previously mentioned. In signal-dense urban areas, it is often necessary to filter the input of broadband amplifiers to prevent competing signals from driving an amplifier's output to its 1dB compression point. An overdriven amplifier generates significant IM and, worse, it will totally saturate, resulting in desensitization to its intended signals.

Noise considerations

▶ *Noise factor and noise figure* — System noise is another anomaly that affects RF propagation. Basically, there are two types of noise. One is inherent to the environment, and the other is generated within the equipment. One might argue these ultimately become the same thing. Here, consideration is given to noise in bidirectional amplifiers and "front-end" noise in typical communications receivers.

The ultimate sensitivity of an amplifier is set by the noise inherent to its input stage. A precise evaluation of an amplifier's performance, as far as noise is concerned, is described by its *noise factor*—the specific numerical proportion of a device's input signal-to-noise ratio (SNR) to its output SNR at a certain temperature and over a certain bandwidth. The logarithmic expression of noise factor is its *noise figure*, and, thus the output noise power generated in a device is given by:

$$P_N = -174 + 10\log BW + G + N$$

where
P_N = noise power in dBm at 290° Kelvin (room temperature)
BW = bandwidth (in hertz)
G = gain (in decibels)
N = noise figure.

Example: From the formula above, total noise power generated in a cellular amplifier with a gain of 40dB, a noise figure of 10dB, and across a 25kHz bandwidth would be −80dBm. This amplifier, if driven to its maximum output power of 1W (30dBm), would have an output SNR of [30 − (−80)], or 110dBm. This is a *huge* SNR, and it affords excellent operation in single-amplifier systems. However, as amplifiers and passive elements are added in cascade (as they are in large distribution systems), noise buildup must be addressed. As distance increases and amplifiers are added, noise performance becomes increasingly critical.

▶ *Amplifiers in cascade* — When several devices are cascaded to form a chain, the whole chain can be evaluated as a single element with a *cascaded noise figure*. The general formula for total *system noise factor* (Fs) is:

$$Fs = F_1 + \left[\frac{F_2 - 1}{G_1}\right] + \left[\frac{F_3 - 1}{G_1 G_2}\right] + \cdots \left[\frac{F_n - 1}{G_1 G_2 G_3 \cdots G_{(n-1)}}\right]$$

where
Fs = system noise factor
$G_1 \ldots G_{(n-1)}$ = numerical gain of individual elements:

$G = \log^{-1}\left[\frac{\text{gain,dB}}{10}\right]$ where loss (in dB) is taken as negative gain

$F_1 \ldots F_{(n-1)}$, $F = \frac{1}{G}$ for passive elements

$F_1 \ldots F_{(n-1)}$, $F = \log^{-1}\left[\frac{N}{10}\right]$ for active elements where N is noise figure.

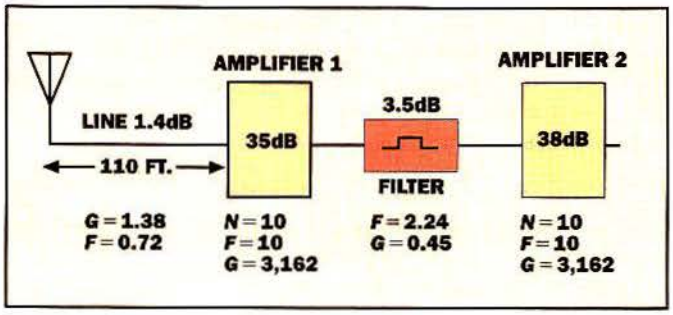


Figure 5. Cascaded amplifier system.

Example: 110 feet of 7/8-inch, foam-dielectric coaxial cable, two bidirectional amplifiers, and a bandpass filter are cascaded as shown in Figure 5 above.

Coaxial cable loss is 1.4dB, amplifier #1 gain is 35dB, amplifier #2 gain is 38dB, noise figure of each amplifier is 10dB, and the insertion loss of the filter is 3.5 dB. The system noise *factor* is:

$$F_s = 1.38 + \left[\frac{10-1}{0.72}\right] + \left[\frac{2.24-1}{(0.72)(3162.27)}\right] + \left[\frac{10-1}{(0.72)(3162.27)(0.45)}\right] = 13.89$$

therefore the system noise *figure* is:

$$N = 10\log 13.89 = 11.43$$

Thus, the noise figure of the cascaded string, 11.43dB, is greater than the noise figure of the first active element in the string, 10dB. This relationship is always true; how much greater the noise figure of the cascaded string is than the first active element depends on the "noise mass" of the string. (Because it makes little difference to the outcome, noise contributions of short jumper cables were not included in this example.) In more formal noise performance evaluations, all noise-contributing elements should be considered.

When a series of cascaded amplifiers, each of gain G, is interconnected, with each driving a load equal to its gain (loss = G), the system is said to be a "0dB system." The system noise factor equation then simplifies to:

$$Fs = F_1 + (F_2 - 1) + (F_3 - 1) + \ldots (F_n - 1)$$

Simplifying further and converting to noise figure, this becomes:

$$N = 10\log[n(F-1)+1]$$

where
N = noise figure
n = number of amplifiers
F = noise factor.

For example, in Figure 5, four sections of cascaded line amplifiers and radiating cable are operating in a "0dB" tunnel system. Each line amplifier of 20dB gain drives a section of radiating cable with 20dB loss.

The uplink noise figure of each line amplifier is 9dB. The noise factor is therefore:

$$F = \log^{-1}\left[\frac{9}{10}\right] = 7.9$$

From the zero dB noise figure equation above, the cascaded noise figure of the amplifier string becomes:

$$N = 10\log[4(7.9-1)+1] = 14.6$$

Noise power out of the string can be evaluated by applying the string noise figure to the last amplifier in the string as if it was operating alone. With a 25 kHz bandwidth this is:

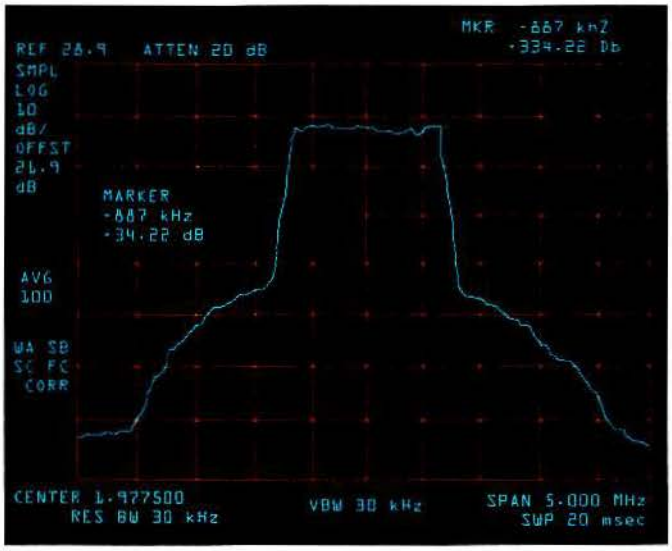


Figure 6. PCS amplifier spectral regrowth at 2W output.

$$P_N = -174 + 10\log 25{,}000 + 20 + 14.6 = -95.4\text{dBm}$$

SNR at the string end is referenced relative to -95 dBm. If the amplifier signal output is +30 dBm, SNR would be

$$(30 - (-95) = 125\text{dB}$$

▶ *Sensitivity* — One definition of sensitivity is "the smallest signal that a network can reliably process." This specifies the strength of the smallest signal at the input of a network that causes the output signal to be *M* times the output noise power. *M* also must be specified, and it is usually "1." Some receiver sensitivity measurement procedures, such as 12dB SINAD, use a slightly different value for *M*. With M = 1, *PN* (noise power) is also the noise floor. For a source temperature of 290°K and across a specified bandwidth, the relationship of sensitivity and noise figure is:

$$\text{Sens}_{(\text{dBm})} = -174 + N + 10\log BW + 10\log M$$

Over a typical channel bandwidth of 25kHz, the basic sensitivity of a typical 1W bidirectional amplifier (N = 10dB) is −120dBm. This is much lower than the −116dBm receiver sensitivity of an ordinary communications receiver.

In the first example above, with two of these amplifiers, cable and filter (N = 11.4), the basic sensitivity would be −119dBm. Thus, noise builds up as component count increases. However, −119dBm is still below typical radio receiver sensitivity, meaning that weak output signals at the threshold of receiver sensitivity would still be discernible above the noise floor. SNR, although not good in this case, would be expressed as (−116dBm − (−119dBm)) = 3dB. In other words, sensitivity is approaching the limit of usability with respect to −116dBm signals.

At any point in a system, or network, a sensitivity calculation indicates if the system is capable of processing signal levels that are expected at that point. In any application, it is vitally important to maintain a sufficient margin of signal power over noise power (SNR). Acceptable SNR is the result of adequate sensitivity.

▶ *Noise and CDMA* — Calculated total output noise power (*PN*) of a typical CDMA amplifier with 95dB gain, noise figure of 6dB and across a 1.25MHz bandwidth is −12dBm. At first, this seems like an alarming amount of noise power, especially compared with a typical base station receiver

sensitivity of −116dBm (0.35mV). Seemingly, noise power of such amplitude would certainly "swamp" the front end of any sensitive receiver. Consider, though, that this noise power will be attenuated by the path loss from the repeater amplifier to the receiver.

Now PCS system designers, integrators, installers and service providers can extend PCS system performance with newer 8W, channelized, bidirectional amplifiers that provide signal level enhancement to the PCS spectrum. An 8W CDMA amplifier has the gain and output power range needed to boost RF signal levels sufficiently for use in a variety of in-building and outdoor null-fill applications and to extend PCS services into locations such as airports, metros, hospitals, parking garages, business parks, campuses or high-rise offices.

CDMA transmission

Figure 6 on page 62 is a test plot of a CDMA 1900 amplifier showing spectral regrowth. The TIA/EIA standard for spectral regrowth requires that average intermodulation measured in a 30kHz bandwidth be 45dB below the average power measured in a 1.25MHz bandwidth. Therefore, the marker delta reading must be corrected by the bandwidth ratio of 1.25MHz/30kHz, or 16.2dB. The plot shown in Figure 6 demonstrates a −50.4dBc intermodulation to composite power ratio. CDMA signals come through unchanged other than having undergone a nominal 3.5ms (either link) throughput delay. The capacity enhancement and transmission advantages of CDMA are totally accounted for in the signal passage through these amplifiers, bringing a new definition to the term "transparent" in CDMA applications.

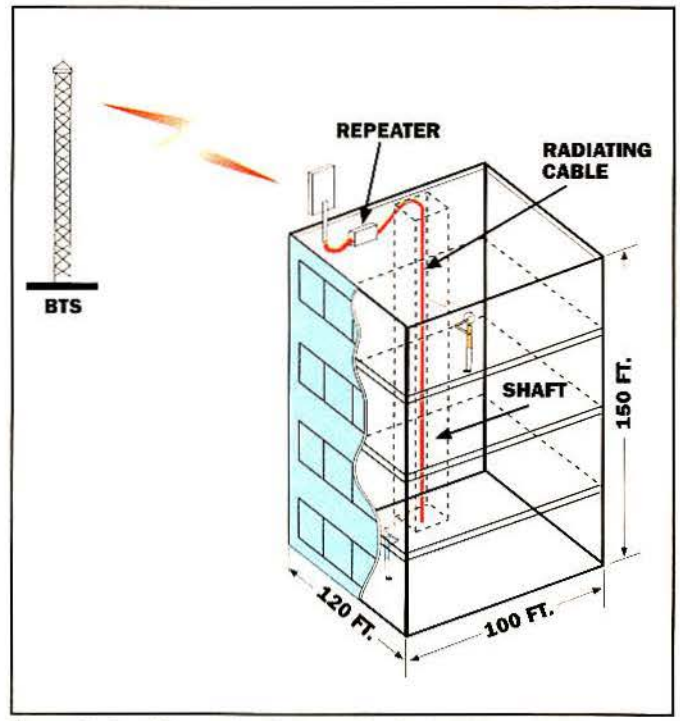


Figure 7. Amplifier and radiating cable for building null fill.

CDMA application examples

▶ *Buildings* — A few examples will show how coverage can be extended into RF-shielded locations with the proper use of amplifiers. In most cases, line losses will not be shown separately. In a real system, line losses are "system-specific" and can be held to reasonably low values by proper

UPLINK BUDGET	
Portable transmitter output, 600mW	+ 27dBm
Portable antenna efficiency	−6dB
Coupling loss to radiating cable @ std. 20 ft.	−69dB
Add for 60 additional ft. (20 log 60/20)	−10dB
Add for 90% coverage	−9 dB
Building interior obstruction losses*	−23dB
Radiating cable line loss, 150 ft.	−12dB
Bidirectional CDMA amplifier gain	+95dB
Outside antenna gain	+15dB
Path loss to BTS, Egli model	−112dB
BTS antenna gain	+15dB
BTS line loss, multicoupler, etc.	−3dB
Uplink signal level into BTS receiver	−92dBm

* Inside building obstruction losses from walls, door, furniture, etc. This quantity should be measured to ensure the best system design. The −23dB is an educated guess only. Actual obstruction loss through 60 ft. in a typical building might be a few decibels more or less than this.

cable selection. Thus, in these examples, when line losses are not shown, they can be assumed to be lumped in with other component losses.

Figure 7 on page 63 depicts a 10-story building of approximate dimensions 150 ft. × 120 ft. × 100 ft. located 1.4 miles from the base station (BTS). The building antenna height is 160 ft. and the BTS height is 40 ft. Calculated (Egli) path attenuation to the BTS is 112dB.

The building is constructed of concrete and steel with metallized, tinted windows, and as such is virtually RF-shielded from the PCS base station. The challenge of extending CDMA coverage into this building can be accomplished with a bidirectional amplifier and 150 ft. of radiating coaxial cable. Radiating cable is the null-fill antenna in this system.

In the link budgets and comments to follow, CDMA transmission and distribution is dealt with as if it were conventional modulation. The example in Figure 7 presumes the system is "uplink-limited" or "talkback-limited." That is, the transmission in the building is poor both ways—but worse in the uplink direction. Therefore, the example will "design to" or tailor performance to the uplink direction, as shown in the budget in the box at the left.

The −92dBm signal into the receiver is 24dB above typical receiver sensitivity of −116dBm. This is "good margin," capable of offsetting other system unknowns or design oversights.

With the knowledge that a workable *uplink* budget can be achieved, the *downlink* budget is then considered. Because the system is uplink-limited, there are no critical downlink considerations. The downlink calculation does, however, provide a good "sanity check" for previous calculations and gives a strong starting point for installation gain adjustments. The downlink budget in the box on page 65 determines that +86dB of gain is needed to reach portable receivers with a signal level of −90dBm.

The −90dBm signal level into the portable receiver is about 26dB above receiver sensitivity. This, too, is "good margin." A gain of only 86dB is required in the downlink, whereas the full amplifier gain of 95dB was necessary in the uplink budget. The required gain difference is attributable to the difference in BTS output power compared with mobile output power. The talkback limitation was a known concern at the outset, and it explains why it was "designed to the uplink" before considering the downlink.

▶ *Highways* — In a rural highway scenario, bidirectional

amplifiers can reduce numbers and costs compared with a BTS-only approach. Typically, one BTS and four amplifiers can be used to obtain greater coverage distance than two base stations. The scheme of one base station and four amplifiers can be extended over long stretches of highway. Obviously, considering capital equipment, backhaul and yearly recurring costs, this can amount to significant savings in the service provider's highway coverage budget. The BTS is the most likely place to start with in the description of a highway system.

In a highway coverage system, reasonable distances can be reached with 100-foot towers. As in most mobile systems, a highway coverage example will be severely limited in the "talkback" direction. Tall towers assure line-of-sight propagation between amplifiers, but the ultimate goal is to reach a mobile on the ground. Tower-to-mobile range is calculated by a range prediction model such as the Egli model. Figure 8 on page 66 shows the downlink range to a mobile that can be expected from a BTS transmitter output of 16W (42dBm). For this example, a 100-foot tower and a 22dB-gain antenna were chosen. Path loss is determined by adding gains, losses, and receiver sensitivity and solving for "*X*." The downlink gain budget from BTS to mobile is:

$$42\text{dBm} + 22 - X - 6 = -95\text{dBm}$$

where
−95dBm = mobile receive target level
22dB = antenna gain
−6dB = portable antenna efficiency
Solving, $X = -153$dB.

With a 100-foot tower, a 22dB-gain antenna and −6dB of receive antenna "gain," a 42dBm-ERP signal will be attenuated by 153dB over the path. Solving the Egli formula for path distance yields:

DOWNLINK BUDGET	
BTS transmitter out, 10W	+40dBm
Line and combiner loss	−5dB
BTS antenna gain	+15dB
Path loss to remote site	−112dB
Receive antenna gain	+15dB
Bidirectional CDMA amplifier gain	+86dB
Radiating cable line loss, 150 ft.	−12dB
Coupling loss from ½" radiating cable @ std. 20 ft.	−69dB
Add for 60 ft (20 log 60/20)	−10dB
Add for 90% coverage	−9dB
Building interior obstruction losses	−23dB
Portable antenna efficiency	−6dB
Downlink signal level into portable receiver	−90 dBm

$$D = \log^{-1}\left[\frac{153 - 117 - 20\log 1{,}900 + 20\log(100\times 6)}{40}\right] = 4.46 \text{ miles}$$

This establishes a BTS talkout range of 4.5 miles. Next, it must be determined if the mobile can talk back to the BTS receiver over the same path. Because the system is talkback-limited, a tower-mounted amplifier (TMA) is required in each uplink receiver. Uplink gain budget from mobile to BTS receiver is:

$$27\text{dBm} - 6 - 153 + 22 + X = -95\text{dBm}$$

where
27dBm = 600mW portable output
−6 = portable antenna efficiency
X = additional gain
Solving, X = 15dB, or the amount of additional gain in the

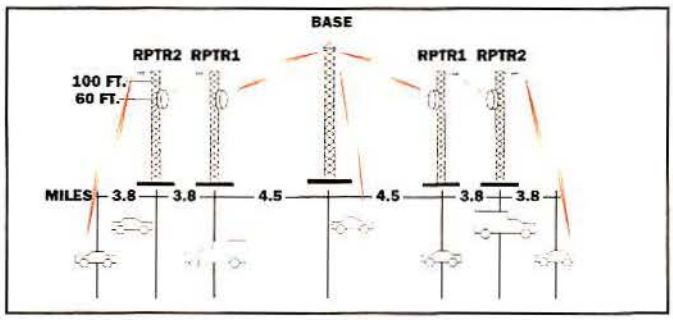


Figure 8. Highway coverage example.

uplink path necessary to establish parity between BTS talkout and mobile talkback.

So, it appears that a 15dB-gain TMA will offset the disparity between talkout and talkback. Unfortunately, because of noise considerations, a 15dB-gain TMA will not deliver a 15dB path improvement.

Path improvement through use of a TMA can be estimated by noise analysis of the receive path on a "before and after" basis, as shown in Figure 9 below. The noise between the antenna and the input to the receiver can be calculated on the "before" diagram. Each noise-contributing element is calculated separately before combining in the cascade noise factor formula, starting at the input jumper.

Input jumper:

$$G = \log^{-1}\left[\frac{-0.3}{10}\right] = 0.93 \text{ and } F = \left[\frac{1}{0.93}\right] = 1.07$$

100-foot, 7/8" line:

$$G = \log^{-1}\left[\frac{-2.0}{10}\right] = 0.63 \text{ and } F = \left[\frac{1}{0.63}\right] = 1.58$$

Duplexer:

$$G = \log^{-1}\left[\frac{-1.1}{10}\right] = 0.78 \text{ and } F = \left[\frac{1}{0.78}\right] = 1.29$$

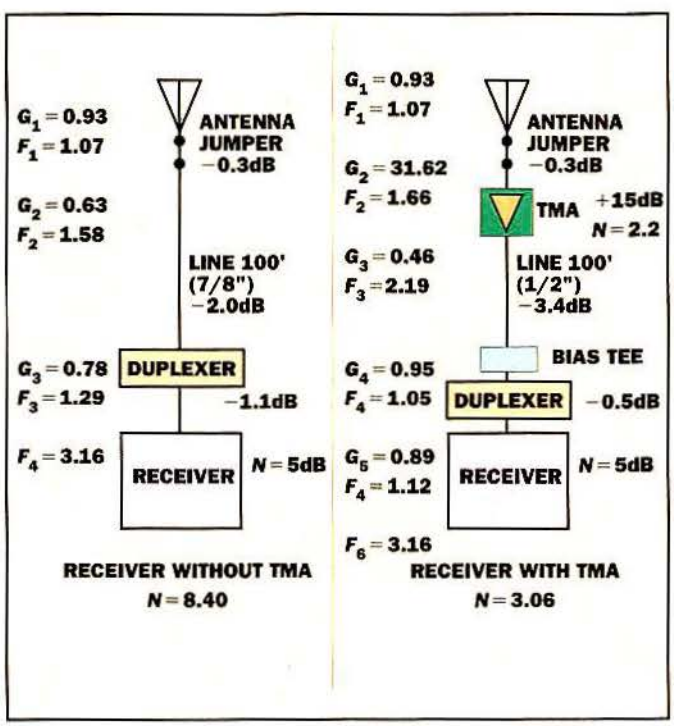


Figure 9. Path improvement with tower-mounted amplifier.

Receiver, with noise figure, N, of 5dB:

$$F = log^{-1}\left[\frac{5}{10}\right] = 3.16$$

Cascade noise factor:

$$F_S = 1.07 + \left[\frac{1.58-1}{0.93}\right] + \left[\frac{1.29-1}{(0.93)(0.63)}\right] + \left[\frac{3.16-1}{(0.93)(0.63)(0.78)}\right] = 6.92$$

Therefore, noise figure of the system without a TMA:

$$N = 10\log 6.92 = 8.40$$

Referring to the "after" diagram in figure 9, system noise figure with a TMA can be calculated. The path through the TMA has special support components including a different duplexer and a bias tee. It also uses a smaller, more economical ½" feeder cable, starting at the jumper.

Input jumper, $G = 0.93$ and $F = 1.07$, same as above.

TMA, with 15dB gain and noise figure of 2.2dB:

$$G = \log^{-1}\left[\frac{15}{10}\right] = 31.62, \quad F = \log^{-1}\left[\frac{2.2}{10}\right] =$$

100-foot, ½"line:

$$G = \log^{-1}\left[\frac{-3.4}{10}\right] = 0.46 \text{ and } F = \left[\frac{1}{0.46}\right] = 2.19$$

Bias tee:

$$G = \log^{-1}\left[\frac{-0.2}{10}\right] = 0.95 \text{ and } F = \left[\frac{1}{0.95}\right] = 1.05$$

Duplexer:

$$G = \log^{-1}\left[\frac{-0.5}{10}\right] = 0.89 \text{ and } F = \left[\frac{1}{0.89}\right] = 1.12$$

Receiver, with noise figure N, of 5 dB:

$$F = \log^{-1}\left[\frac{5}{10}\right] = 3.16$$

By the cascade noise factor equation:

See the box at the top of page 67.

Therefore, noise figure of the system *with* a TMA:

$$N = 10\log 2.02 = 3.06$$

Noise figure improvement amounts to subtraction of the before and after noise figures, or 8.40 − 3.06 = 5.34dB. Five decibels of noise figure improvement translates to the same amount of improvement in talkback conditions. In essence, the addition of a 15dB TMA yields a 5.3dB improvement or enhancement in the talkback path.

Interestingly, the difference between the basic sensitivities is also 5.34dB.

Path improvement depends heavily on ambient noise and component losses but is rarely more than 7dB without the use of cryogenic amplifiers. The BTS corrected receiver input calculation now becomes:

$$27\text{dBm} - 6 - 153 + 22 + 5.3 = -104.7\text{dBm}$$

The BTS designed to deliver −95dBm to a mobile receiver at 4.5 miles will receive a talkback level of −105dBm from mobiles at the same distance. Even though total range is less than on the downlink side, good performance at 4.5 miles is

CASCADE NOISE FACTOR EQUATION:

$$F_s = 1.07 + \left[\frac{1.66-1}{0.93}\right] + \left[\frac{2.19-1}{(0.93)(31.62)}\right] + \left[\frac{1.05-1}{(0.93)(31.62)(0.46)}\right] + \left[\frac{1.12-1}{(0.93)(31.62)(0.46)(0.95)}\right] + \left[\frac{3.16-1}{(0.93)(31.62)(0.46)(0.95)(0.89)}\right] = 2.02$$

assured because the BTS receive level of −105dBm is 11dB above minimum receiver sensitivity.

In summary, with the parameters set forth, the BTS to mobile range is 4.5 miles. Mobile talkback limitations cannot be completely overcome with tower-mounted amplifiers. The realizable talkback gain of 5dB in the TMA supports only partial parity between talkout and talkback. Some service providers reduce, or pad down, transmitter outputs to maintain exact parity with the best obtainable uplink.

Ranging the repeater to mobile distance

Now that the base station to mobile range has been determined, the next step is to find the repeater to mobile ranges. Because the output power and height of each repeater is the same, the potential downlink range to mobiles from each repeater site will be the same. It stands to reason that the repeater sites should not be separated by any greater distance than their talk-out range, or range to mobiles. This range is determined by the output power of the repeaters. With a repeater power output of +39dBm (8W) and a mobile target receive level of −95dBm, path loss and repeater downlink range are calculated:

$$\text{path} = 39 + 22 - X - 6 = -95 \text{ and, solving,}$$
$$X = 150\text{dB path loss.}$$

Distance via the Egli formula is:

$$D = \log^{-1}\left[\frac{150 - 117 - 20Log1900 + 20Log(100x6)}{40}\right] = 3.8 \text{ miles}$$

The downlink range of each repeater is 3.8 miles because they all have the same +39dBm (8W) output power. Essentially, for each repeater to reach a mobile at maximum range, the repeater towers must be spaced 3.8 miles apart. Compare this with the range of 2W (+33dBm) repeaters, which would be only 2.7 miles.

With known intertower distances, the next step is to work out details pertaining to the "backbone" part of the system — the RF link between towers. Preliminary calculations indicate that line-of-sight propagation exists between towers at the 80-foot and 100-foot heights. Vertical antenna separation of 20 feet on each tower ensures adequate isolation between uplink and downlink. Calculated free space loss over 4.5 miles between the BTS and first repeater is 111dB and that between repeaters is 109dB. Link power levels can now be determined by adding gains and losses.

Backbone downlink signal from the base transmitter through the first repeater is calculated:

42dBm BTS out + 22dB base antenna gain
−111dB path loss + X = 39dBm repeater output

where
39dBm = 8W CDMA output of the amplifier
X = total downlink gain at repeater 1.

POWER FLOW BUDGET	
+42dB	BTS transmitter out
+22dB	Antenna gain
−111dB	Path loss between BTS and repeater 1
+12dB	Repeater 1 antenna gain
+74dB	Repeater 1 downlink gain
(+39dBm)	Repeater 1 output
+22dB	Repeater 1 antenna gain
−109dB	Path loss between repeater 1 and repeater 2
+12dB	Repeater 2 antenna gain
+75dB	Repeater 2 downlink gain
(+39dBm)	Repeater 2 output
+22dBm	Repeater 2 antenna gain
−150dBm	Path loss between repeater 2 and mobile
−6dB	Mobile antenna efficiency
(-95dBm)	Signal level into mobile receiver

Solving for X indicates 86dB total gain is needed to drive the repeater to its full rated output power of 39dBm, or 8W. Gain adjustments on the amplifier used in this example gives the option of choosing more economical, lower-gain antennas in the downlink. Opting for a 12dB-gain antenna, the balance of the required 86dB can be provided by the downlink amplifier. Gain of the amplifiers is adjustable from 65dB to 95dB. In this case, downlink gain would be set for (86 − 12), or 74dB.

The backbone link between the two repeaters is calculated in similar fashion:

39dBm repeater 1 output + 22dB antenna gain
− 109dB path loss + X = 39dBm (repeater 2 output)

Solving for X, this works out to 87dB, and again the antenna can contribute 12dB, requiring a balance of 75dB from repeater 2, which is also driven to its full 8W or +39dBm output. As determined earlier, 39dBm plus 22dB antenna gain at each repeater site will deliver −95dBm into mobile receivers 3.8 miles away.

As a check of the backbone downlink calculations, a "power flow" budget would be as shown in the box at the left.

All that remains is to calculate the uplink backbone gain values. Other elements in the uplink are now fixed.

To review, there are 22dB-gain, top-mounted antennas and tower-mounted amplifiers in each uplink location, including the BTS. Uplink antennas of 12dB gain are at the 80-foot level of each repeater tower. Before completing the uplink backbone calculations, it is necessary to determine the amount of path enhancement contributed by the tower-mounted amplifiers working into the repeaters. Previously, uplink path enhancement at the BTS receiver was found to be about 5dB. Tower-mounted amplifier enhancement should be evaluated again for the repeaters because the TMAs are working into different noise figures than in the receiver.

The amplifier noise figure is 6dB and its noise factor, F, is 3.98. The noise factor calculation will be the same as for the TMA/receiver, except for the last term, which now contains the amplifier noise factor of 3.98. Noise factor of an uplink repeater with a TMA and (repeater) amplifier is calculated as:

(See the box at the top of page 69.)

and, uplink noise figure with a TMA and amplifier is

$$N = 10\log 2.09 = 3.2\text{dB}$$

To find the amount of TMA enhancement in the uplink repeaters, it is necessary to calculate the noise figure with no

Noise factor of an uplink repeater with a TMA and (repeater) amplifier:

$$F_s = 1.07 + \left[\frac{1.66-1}{0.93}\right] + \left[\frac{2.19-1}{(0.93)(31.62)}\right] + \left[\frac{1.05-1}{(0.93)(31.62)(0.46)}\right] + \left[\frac{1.12-1}{(0.93)(31.62)(0.46)(0.95)}\right] + \left[\frac{3.98-1}{(0.93)(31.62)(0.46)(0.95)(0.89)}\right] = 2.09$$

TMA and subtract the noise figure with TMA, 3.2 dB above. Noise factor with no TMA is:

$$F_s = 1.07 + \left[\frac{1.58-1}{0.93}\right] + \left[\frac{1.26-1}{(0.93)(0.63)}\right] + \left[\frac{3.98-1}{(0.93)(0.63)(0.78)}\right] = 8.66$$

and $N = 9.4$dB.

Therefore, the amount of uplink repeater path improvement with TMAs is 9.4dB − 3.2dB = 6.2 dB.

Backbone uplink signal level from the mobile into the first repeater is calculated:

27dBm, mobile out − 6 dB, antenna efficiency
−150dB, path loss + 22dB, antenna gain + 6dB, TMA
= −101dBm into repeater 2 amplifier.

To determine the required amplifier gains in the two uplink repeaters, an equation of gains and losses from the input of repeater 2 all the way back to the input of the BTS receiver is set up:

− 101dBm	Repeater 2 input
+ X	Repeater 2 uplink amp gain
− 12dB	Antenna gain
− 109dB	Path loss between repeaters
+ 22dB	Antenna gain
+ 6dB	TMA
+ X	Repeater 1 uplink amp gain
+ 12dB	Antenna gain
− 111dB	Path loss between repeater 1 and BTS
+ 22dB	BTS antenna gain
+ 5dB	BTS TMA
− 95 dBm	BTS receiver input

Where X = amplifier uplink repeater gain

Solving, $2X$ = 147dB total gain. Splitting the gain between the two uplink amplifiers gives 73.5dB gain in each amplifier. An uplink backbone "power flow" budget would be:

POWER FLOW BUDGET	
+27 dBm	Mobile output
−6 dB	Mobile antenna efficiency
−150 dB	Path loss between mobile and repeater 2
+22 dB	Repeater 2 antenna gain
+6 dB	TMA enhancement
(−101 dBm)	Repeater 2 amplifier input
+74 dB	Repeater 2 uplink gain
+12 dB	Antenna gain
−109 dB	Path loss to repeater 1
+22 dB	Repeater 1 antenna gain
+6 dB	TMA enhancement
(−96 dB)	Repeater 1 amplifier input
+74 dB	Repeater 1 uplink gain
+12 dB	Antenna gain
−111 dB	Path loss between repeater 1 and BTS
+22 dB	BTS antenna gain
+5 dB	TMA enhancement
(−94 dBm)	Signal level into BTS receiver

In summary, highway repeater tower locations are specified based on downlink transmit power from the base station and subsequent repeaters. Then, the ability of mobiles to talk back in the uplink to each location is verified. Because of inherent talkback limitations, it is usually necessary to use tower-top amplifiers in each uplink path. Next, the intertower or backbone portion of the repeater system is established. The wide range of gain adjustment available in the amplifiers used in this example leads to efficient level management in the backbone. Accordingly, it is possible to use lower gain, more economical antennas in parts of the backbone.

▶ *Tunnels* — A CDMA 1900 amplifier and radiating cable are a great combination for solving tunnel or other "shielded conduit" passageway coverage problems. The following example considers an 1,800-foot tunnel located about1.0 mile from the PCS cell site. Coverage in the tunnel is provided by $^7/_8$" radiating cable.

Typical of most urban situations, this example assumes the remote antenna is not within line of sight of the BTS. Attenuation calculated with the Egli Model shows about 120 dB over the path. In actual design situations, path loss should be measured. Worst case link budgets look like this:

DOWNLINK BUDGET	
BTS transmitter combiner	+37dBm (5W)
Antenna gain	+17dB
Path loss, 1 mile	−120dB
Remote antenna gain	+12dB
Line loss	−2dB
Amplifier input signal	(−56dBm)
Amplifier gain	+95dB
Amplifier output	(+39 dBm, 8W)
Jumper-connector loss	−1dB
1800-ft radiating cable (2.44 dB/100')	−44dB
Radiating cable coupling loss, 50% coverage	−74dB
Add for 90% coverage	−9dB
Mobile antenna efficiency	−6dB
Signal level inside automobile	−95dBm

UPLINK BUDGET	
Portable out	+27dBm
Mobile antenna efficiency	−6dB
Radiating cable coupling loss, 50 % coverage	−74dB
Add for 90% coverage	−9dB
1,800-ft radiating cable (2.44 dB/100')	−44dB
Jumper-connector loss	−1dB
Amplifier gain	+95dB
Amplifier output	(-12dBm)
Line loss	−2dB
Remote antenna gain	+12dB
Path loss, 1 mile	−120dB
BTS antenna gain	+17dB
Input to BTS receiver	−105dBm

No tower-top amplification was specified in the uplink, although the −105dBm talkback signal to the BTS receiver might warrant the use of a TMA. About 5dB of talkback improvement could be expected with TMA. It would assure better parity between talkout and talkback. However, the system designer must make a judgment call with respect to added cost vs. improvement in performance.

Creating a ubiquitous network

As PCS systems are built out, designers will most certainly be confronted with the problem of null filling. Bidirectional CDMA amplifiers and tower-top amplifiers can help with the most challenging system designs. ■

Transcrypt forms three new units

In an effort to further strengthen its position in the wireless systems and digital radio product markets, Transcrypt International is forming three new business units at its EF Johnson subsidiary. The State, Local and Commercial Business Unit will be led by Jim Ridgell as senior vice president and general manager. Ridgell joins the company from Microdyne, where he served as the COO of the Advanced Technology Unit. This new business unit will focus on marketing, sales and turnkey delivery of public safety and commercial private wireless communications networks. EF Johnson's strategy is to support these markets as they transition to the APCO Project 25 digital trunked radio protocols.

The federal government's adoption of the Project 25 standard should have a positive effect on the new Federal Business Unit, which will be managed by Craig Szczutkowski, the recently named unit senior vice president and general manager. This unit will concentrate on sales of EF Johnson's digital Project 25 products to federal government agencies. Szczutkowski will hold the same position in the Value Added Services and OEM Business Unit, which is being formed to consolidate EF Johnson's OEM production services, and engineering and support services. Szczutkowski, who has more than 20 years of experience in the wireless communications industry, will also serve as chief technology officer for the EF Johnson subsidiary.

Increasing revenue is expected as customers transition from analog to digital systems over the next five years. Michael Jalbert, Transcrypt chairman, said that the company will focus future product development on designing digital projects and systems that can interface with its customers' network to handle voice and data between fixed and wireless backbones.

"We will further enhance on our leadership position in the APCO Project 25 arena," Jalbert said.

Plans are also underway for EF Johnson to open offices in the metropolitan Washington, DC, area and to explore opportunities in the federal and commercial markets.

ATX, Trueposition team for telematics services

An alliance formed by ATX Technologies, San Antonio, TX, and Trueposition, King of Prussia, PA, outlines the joint development of telematics products and services enabled by network-based location identification technology. The plan is to develop network-enabled versions of ATX telematics services for the wireless and automotive markets, while collaborating on additional new products and services. The companies expect to trial their telematics services during the first quarter of 2000 with a major wireless carrier.

Several services are being considered for the trial, including manually activated emergency calls, in which a telematics subscriber activates an emergency call feature to transmit location and vital information to the response center. Or, with a roadside assistance feature, a subscriber can contact the response center for location verification and assistance in contacting a roadside service provider.

With a proper password, a person can achieve peace of mind by using the lost-and-found service to locate missing or delayed persons carrying a handset device. Emergency navigation provides turn-by-turn directions to a specified address or, for the lost or distressed traveler, this feature can offer essential details such as locations of ATMs, gas stations and hotels. Other possible trial services include enhanced roadside assistance and voice navigation.

ATX location-based services can be enabled by most location-identification technologies, including GPS, and they are deliverable to most types of wireless communications terminals. Trueposition's Wireless Location System technology uses a patented time distance of arrival (TDOA) product to determine geographical position, direction of travel and velocity of mobile transmitters. The company developed this network-based product to assist wireless carriers in meeting FCC Phase II requirements for locating wireless 911 calls.

Cooper headlines RCA breakfast

Industry veteran Marty Cooper, chairman of Arraycom, San Jose, CA, will be the featured speaker at the Radio Club of America breakfast gathering scheduled for 7:30–9:00 a.m., March 23 at IWCE '00 in Las Vegas. Attendees at the early-morning meeting will hear Cooper's industry insights and predictions at the Las Vegas Hilton, Pavilion #10, before heading off to the day's opening exhibits. The full breakfast is co-sponsored by Com-Net Ericsson, Maxrad, Intertec Publishing (publisher of *Mobile Radio Technology* and owner of IWCE) and Radiomate.

Cooper

Wisconsin orders $1 million in dispatch software

HTE of Lake Mary, FL, is set to deliver $1 million worth of public safety software to the Wisconsin State Patrol. A contract with the patrol details an installation that will encompass all seven districts throughout the state, which together house nine state patrol facilities. The deal calls for HTE's CAD V dispatching software, the Crimes Record Management System and Integrated Mapping.

Under terms of the new contract, HTE will integrate the patrol's existing HTE mobile system with CAD V so that officers can receive dispatch information, update their status and run queries from in-vehicle computers. The computer-aided dispatch application combines with mobile integration to assist in meeting the fast-paced needs of the state patrol. The Crimes software enables law enforcement agencies to record extended incident information. The mapping option provides an on-screen, pictorial reference of an entire jurisdiction.

Test companies merge create $800M union

TTC, a unit of Dynatech based in Germantown, MD, and Wavetek Wandel Goltermann (WWG), Research Triangle Park, NC, announced merger plans to create a new company with broader capabilities in test and monitoring for the worldwide communications industry. TTC and WWG, recognized as number two and three in their market, expect the merger to result in an expanded product and service portfolio and a stronger global presence.

The new business, which will announce its name at a later date, will have more than $800 million in worldwide revenue and more than 4,000 employees. The company will also invest $135 million annually in research and development.

While WWG maintains a strong market position in Europe, Latin America and Asia/Pacific, TTC's focus is in North America. WWG sells optic and testing systems to service providers and test equipment to manufacturers. TTC's line includes transmission, data instruments, systems and software products.

"By combining the number two and three companies in the market, we will create a strong challenger for the top position worldwide," said Ned Lautenbach, Dynatech's chairman. "The companies are an excellent fit with largely complementary product offerings, and sales and distribution channels. This combination will allow us to deliver even greater competitive advantage to our customers and has the potential for significant growth opportunities worldwide."

Lautenbach, who will be chairman of the new company, is also principal of Clayton, Dubilier & Rice, a private investment firm that manages a fund owning about 70% of Dynatech on a fully diluted basis.

Other top management position appointments include Peter Wagner, current president of WWG, as vice chairman. John Peeler, currently president of TTC, will be president for the new company. Albrecht Wandel of the former Wandel & Goltermann will act as chair of the International Advisory Committee and work with Lautenbach on the new company's international strategy.

For additional information on the merger between TTC and WWG, visit **www.power2lead.com.**

Sonik enters exclusive distribution alliance

In a strategic alliance with Shanghai Motorola Paging Products Company (SMPPC), Sonik Technologies, San Marcos, CA, has accepted an exclusive distribution agreement for SMPPC's paging infrastructure transmitters in the Americas. According to agreement terms, Sonik will initially provide private-label distribution for the PTX-150 family of VHF paging transmitters, which meets industry requirements for Flex and simulcast operation. Sonik will also provide system design and integration services to paging customers.

Sonik's existing product lines include the Pagepro paging transmitters, Dspage paging exciters, Pagelink paging data receivers RF Audience II, ReFlex 25 paging infrastructure receivers and Skyline wireless modems. China-based SMPPC, a joint venture of Motorola and several Chinese companies, currently supplies paging products to the in-country market. With this agreement, SMPPC begins distributing to other world markets.

FCC Notes

Sweeping up that old backlog

In an order released March 1, the Commercial Wireless Division (CWD) of the Wireless Telecommunications Bureau (WTB) dismissed petitions filed by **Roamer One** and **Pagers Plus Cellular** on behalf of 27 non-nationwide 220MHz licensees to modify rules affecting relocation of authorized base stations. Waiver requests had been denied by the old Land Mobile Branch of the WTB's Licensing Division (now the Licensing and Technical Analysis Branch of the CWD) in April 1997. The petitions for reconsideration that were filed one month later in May of 1997 were the same petitions that the FCC finally dismissed this month. In 1996, the FCC gave 220MHz licensees a time frame between March and May to file modification applications to relocate base stations. Waiver requests, denied a year later in 1997, cited "unforeseen and widespread" delays and dropped transmissions experienced with the FCC's electronic filing system. Roamer One, the systems manager, and Pagers Plus, the preparer, asserted that the system glitches had extended the transmission time from minutes to hours during the spring of 1996 and that disconnects required complete resubmissions, thus extending the filing time past the deadline and requiring time waivers requests to be filed. The Licensing Division denied the requests a year later, saying that because technical difficulties had been experienced more than 30 days out from the deadline, and because manual filing options existed, the deadline was not beyond the control of the applicants. The FCC also denied that the computer filing problems were widespread. Petitions for reconsideration were filed 30 days later.

In denying those Petitions for Reconsideration in March, the CWD held under FCC rules that Roamer One and Pagers Plus do not qualify as "parties of interest" to be petitioners because they were not the actual licensees. The CWD also held that neither entity had demonstrated a direct injury that would result from the waiver denials. However, the CWD did recognize the 27 licensees who joined the reconsideration petition as parties of interest. In denying the petition, the CWD supported the original waiver denials saying that alternative filing methods existed. The CWD also contended that because no other applicants had complained about the electronic filing system, the problem must not have been widespread. Roamer One asserted that manual filing should not have been necessary because the burden was on the FCC to suspend electronic filing or to extend the filing deadline when problems were reported. Roamer One also argued that the commission staff had recommended that Pagers Plus continue to file applications after deadline and had indicated that waiver requests would be considered. The CWD refuted the first argument by saying that electronic filing was an option, not a requirement. In the second case, the CWD held that alleged statements by the staff do not support grant of relief. Roamer One also argued that denying waivers in the case would have a chilling effect on increased electronic filing, which is a commission policy goal. The CWD's dismissal said that "while the commission does in fact encourage electronic filings, parties availing themselves of this method of filing are not excused from the requirements of due diligence." All affected applications for modification of licensees were dismissed.

New deputy chief for policy

Blaise Scinto has been named as deputy chief of the Policy Division of the Wireless Telecommunications Bureau. Scinto was formerly deputy chief of the Network Services Division of the Common Carrier Bureau (CCB) and had previously served as legal counsel to three successive chiefs of the CCB.

Motorola selects Huber+Suhner as a supplier

Motorola's Network Solutions Sector (NSS) has selected Huber+Suhner as one of its global suppliers of transmission line products. Huber+Suhner will support Motorola NSS facilities in the United States as well as China, Brazil and the United Kingdom.

The company was selected as part of Motorola's Strategic Ancillary Sourcing Program (SASP). The program, designed to reduce the number of suppliers used by Motorola, aids the development of long-term partnerships with companies that can support their operations worldwide. Huber+Suhner was selected after a quality audit at its global headquarters in Herisau, Switzerland. Huber+Suhner will supply transmission line products, including Sucofeed cable and Quick-fit connectors.

Nextel launches Internet-ready phone

New Nextel subscribers had something to call home about in January when Cost Control Consultants, a landline and wireless communications consultant and national Nextel master agent, announced five plans from Nextel Communications. With these plans, new subscribers can receive incoming calls from anywhere in the United States or Canada without those minutes subtracting from their bundled cellular and long-distance minutes.

Traditionally, inbound and outbound cellular calls have been subtracted from a subscriber's minute bundle. With the "One Rate" pricing, which blends cellular and long-distance usage, cellular users have a pricing alternative to consider. For new activations before Feb. 29, only outbound calls are subtracted from the overall minutes.

Also new from Nextel is its third Internet-ready phone, the rugged i700plus. This unit combines the capabilities of digital cellular, text/numeric paging and Nextel Direct Connect (digital two-way radio), and contains a Web browser for future access to Nextel web-based services. The phones, available in yellow or black, feature black rubber grips for added protection and are appropriate for the communications needs of builders, developers, contractors and field workers.

Enrev receives $25 million investment

Enrev, Norcross, GA, has closed a $25 million equity investment round, bringing the total of private investment to $41 million. European Institutional Advisors (EIA), a merchant banking firm, coordinated the group of 12 major institutional investors from the United States and Europe, which includes numerous strategic relationships in the telecommunications and wireless industry. The Enrev battery operating system (B.O.S.) technology was awarded the Frost and Sullivan Market Engineering Product Innovation Award and is licensed to manufacturers of wireless devices.

Robinson

"The strategic value of this investment is key to Enrev Corporation's long-term plan for growth and market expansion," said Karen Robinson, Enrev's chairman. "It brings us world-class connections to the wireless and telecommunications industries. In an oversubscribed round, we were able to select investments with the strongest partnership potential."

The B.O.S. software, effective with all major battery chemistries, is supposed to increase platform stabilization and deliver consistent, more reliable battery performance.

Investors named in the $25 million round include: Benevolent AG, Switzerland; Darier, Hentsch & Cie, Switzerland; Invus AB, Sweden; Island Capital Management, New York; Swiss Partners Investment Network GrowUnique fund, Switzerland; Paribas/Courcoux Bouvet, France; S Squared Technologies, New York; Sands Brothers Ventures, New York; and Vereins und Westbank, Germany.

Vision Software pens $370,000 contract

The Sauk County Sheriff's Office in Wisconsin signed a $370,000 contract with Vision Software, Castle Hayne, NC, for the installation of a new computer-aided dispatch (CAD), law enforcement records management system (RMS), wireless information system (Mobile) and Jail Management (Jail) software. The software, which is part of Vision Software's integrated Public Safety Suite, operates on a WindowsNT platform. The Suite includes VisionCAD, VisionRMS, Visionmobile, Visionjail, Visionfire, VisionEMS, Visioncourt and Visiongeo.

Andrew, Channel announce partnership

In an effort to broaden their individual ranges of earth station antenna products, Andrew and Channel Master have formed a strategic alliance. Channel Master designs and produces antennas and accessories, with antenna sizes ranging from 0.35m to 3m. Andrew's line of fixed and motorized earth station antennas range from 1.2m to 9.3m. The alliance allows both companies to immediately extend their product lines and better provide for their customers' diverse requirements.

While Gene Hammond, Andrew's vice president, sees the Channel Master products as a natural, complementary extension to his company's current line, Channel Master management expects mutual benefits. "The ability to capitalize on Andrew's global presence and to include their antennas as part of Channel Master system proposal is a key benefit to our company and customers," said Buddy Mills, president of Channel Master.

Pacific Wireless sets sites for IDEN net

Pacific Wireless Technologies, Fresno, CA, will use Motorola IDEN equipment to build a digital SMR network with a "twist."

BACE Capital Partners, along with its investors, Sagaponack Partners, Sagaponack International Partners and Rocky Mountain Mezzanine Fund II, provided venture capital to create and fund Pacific Wireless. The company then acquired and combined Sierra Communications and Cumulous Communications, two of the largest independent dispatch analog SMR service providers in the San Joaquin Valley of central California. The region has an estimated seven million potential digital mobile communications subscribers.

Analog SMR systems typically use high-power, high-elevation sites. Digital ESMR systems typically use low-power, low-elevation sites. The "twist" is that Pacific Wireless intends to install IDEN equipment at high-power, high-elevation sites, including the mountains bordering the valley, converting its inventory of more than 300 analog 25kHz channels to digital use.

Motorola's time-division, multiple-access (TDMA) technology will deliver a six-to-one capacity increase compared to analog FM. Pacific Wireless will forfeit additional capacity increases normally yielded by ESMR frequency reuse. But placing its sites at high elevations means that it will need fewer of them, so its infrastructure will cost less, potentially allowing the company to offer service at a lower price than ESMR companies.

Pacific Wireless will use IDEN to offer two-way radio, wireless telephone and text messaging to agricultural, construction, distribution and trucking companies, and government agencies. Service is expected to be available this spring in Stockton, Sacramento, Fresno, Bakersfield, Modesto and other portions of the south central California coastline. The company will offer roaming in San Francisco and Tahoe, CA, and Reno, NV.

The San Joaquin Valley is an area where Nextel Communications has relatively limited coverage. SMR operators in the valley have been reluctant to sell their systems to Nextel. Also, they control the best mountaintop sites and have been reluctant to lease space to Nextel for what few channels it has been able to acquire. As a result, Pacific Wireless has an opportunity to sell IDEN service with little competition from Nextel.

Pacific Wireless has hired Jeffrey Fuller as president. Fuller was instrumental in setting up Pacific Wireless and arranging the acquisitions. He most recently headed Transcrypt International, Lincoln, NE, and has had sales, marketing and executive management responsibilities at Motorola, EF Johnson and General Electric Mobile Communications.

Dan Kopp is vice president of marketing; Gregory Glenn is director of network operations; Darin Alvord is director of switch operations; Ken Gilstrap is director of indirect distribution; and Damon Silva is director of new business development at Pacific Wireless. *DB*

Applied Power spins off electronics business

Applied Power, Waukesha, WI, plans to spin off its electronics business from its industrial business to create a pure global supplier in the high-growth electronic manufacturing services (EMS) sector. The new company, to be called APW, will be a large player in the $90 billion EMS industry focused on integrated electronic enclosures systems. As part of the spin-off, APW will be converted to a Bermuda corporation. The spin-off should be tax-free to Applied Power shareholders.

Applied Power's current industrial business segment will operate on a stand-alone basis, and will remain incorporated in Wisconsin.

The spin-off is expected to be completed by fiscal year-end, at which time, each Applied Power shareholder of record would receive a dividend of one newly issued share of APW for each Applied Power share they hold.

"Over the past several months, we have been evaluating a range of alternatives to separate our electronics and industrial businesses," said Richard G. Sim, chief executive officer of Applied Power. "The spin-off of APW from Applied Power provides for a clean and efficient separation of the industrial and electronics businesses, enabling each company to concentrate on its core business. This permits shareholders to make more focused investment decisions and allows the market to assign a more appropriate stand-alone valuation to each company."

News Notes

Odetica Telecom, Anaheim, CA, a provider of timing and synchronization products, has changed its name to **Zyfer**. "The decision to change our company name to Zyfer directly reflects our new strategic direction. In addition to expanding our growing telecom synchronization business base, we are leveraging our expertise to enter the network and mass media data security market," said **Hugo Fruehauf,** president of Zyfer. ... **Airxcel**, Cordele, GA, is separating **Crispaire**, its Georgia-based air-conditioning company, into two divisions: the Marvair Division, with manufacturing based in Cordele, GA, and the Crispaire Division, with manufacturing based in Norcross, GA. "This change increases our ability to meet customer needs more effectively," said **Mel Adams**, Airxcel president. ... **The Dispatch Bookstore**, now in Platteville, WI, has changed hands. **Leslie Marquardt** has assumed operation from **Alan Burton**. "I intend to run the business with the same high degree of quality and service that Alan Burton has provided the dispatching community through the years," said Marquardt. "I look forward to the challenge of providing materials for one of the most underrated and underappreciated groups in the world—dispatchers." ... **David Clark**, Worcester, MA, has opened authorized repair facilities in Europe and Australia. "The addition of these professional partners enables David Clark to service our rapidly growing international customer base with factory authorized warranty repairs," said **James Comer,** international sales manager.

Marquardt

The Quebec government, in cooperation with the Quebec Movement for Quality, has awarded **Harris,** Redwood Shores, CA, its 1999 Grand Prize. The award recognized Harris' achievements in all aspects of total quality management. ... **Cerulean Technology,** Marlborough, MA, has been named to **Deloitte & Touche's** "Fast 500" Program, a ranking of the 500 fastest-growing U.S. technology companies. "We attribute the remarkable growth of the company's software and services revenue of more than 4,100% in five years to our team of dedicated men and women who have worked hard to make Cerulean a significant contender in the wireless market," said **Bob Badavas**, president of Cerulean.

Hirschmann, Pine Brook, NJ, has been selected by **Metricom**, Los Gatos, CA, as a supplier of custom-designed Wired Access Point antennas. ... **Georgia-Pacific's** Building Products Distribution Division has Opurchased Clemmons, NC-based **Eaton's Trucking Information Services'** Fleet Advisor.

APCO breaks ground for new building

The Association of Public-Safety Communications Officials (APCO) International held its official groundbreaking ceremony on Feb. 6 for its new headquarters, the J. Rhett McMillian Jr. Building, in Daytona Beach, FL.

APCO board members, executive council members, employees and area dignitaries attended the ceremony held at the Christ Community Church reception hall next to the 3.5-acre site where the building will stand.

APCO named the building to honor the late McMillian, a past APCO president and the organization's first employee. McMillian was responsible for transforming APCO, originally a police organization, into a not-for-profit professional organization dedicated to the enhancement of public safety communications.

APCO members hope that the new 13,000-square-foot building will help make the organization more visible to the local population.

APCO's Web site: **www.apco911.org.**

Simmonds Capital to sell A.C. Simmonds & Sons division

Simmonds Capital Ltd. (SCL), Willowdale, Ontario, Canada, plans to sell its A.C. Simmonds & Sons division to a company named "1370388 Ontario" and known as "ACS Acquisition."

A.C. Simmonds & Sons was originally a family business started by A.C. "Claude" Simmonds in 1917. It grew as a Canadian manufacturer's stocking representative and distributor. It distributed EF Johnson radio products until the business split in the 1970s when Claude Simmonds' son, David Simmonds, started Lenbrook Industries. To replace this gap at A.C. Simmonds & Sons, another of Claude's sons, John Simmonds, began distributing Midland land mobile radio products in Canada. This Canadian business was subsequently sold to form part of Glenayre Electronics, giving the Simmonds family an interest in Glenayre.

In 1991, John Simmonds formed SCL to distribute Midland products in Canada. SCL later acquired A.C. Simmonds & Sons. A.C. Simmonds & Sons operates three sales groups focused on professional audio and video; consumer audio and video; and residential custom installation in Canada.

ACS Acquisition was formed by some of the senior managers of an SCL subsidiary, SCL Electronics, other employees of the A.C. Simmonds division, and other investors.

SCL expects to net about $1.8 million from the sale and collection of accounts receivable. SCL will retain a 20% equity interest in ACS Acquisition.

SCL is in the process of selling its remaining operating businesses, including its SCL Technologies manufacturing division, to focus on the management and development of its strategic investments. Those investments include minority shareholdings in several Internet service companies and in Trackpower, a live video service that broadcasts horse races to home viewers and facilitates in-home wagering.

SCL also is advising Relm Wireless, West Melbourne, FL, regarding financing, acquisitions and business strategy.

OEM Hitachi merges with Kokusai, Yagi

Hitachi Ltd., Tokyo, will merge its Hitachi Denshi subsidiary with two other companies, Kokusai Electric and Yagi Antenna, on Oct. 1.

In the land mobile radio industry, Hitachi Denshi is known for manufacturing products for Securicor Wireless that in the United States previously carried the Midland brand. It has an agreement to manufacture mobiles for ComSpace, which offers DC/MA products. Hitachi Denshi has been in negotiations to sell to Relm Wireless some tooling that Hitachi Denshi owns to make FM two-way radios and to develop new products that Relm would sell.

The merger is expected to allow Hitachi Denshi, Kokusai and Yagi to concentrate their resources in wireless communications. The combined company tentatively has been named Hitachi Kokusai Electric. In addition to serving its current mobile communications system customers, the new company will pursue new business in IP networking, digital broadcasting and intelligent transport systems. Within mobile radio, the new company wants to expand its business in systems for disaster control, airport and public safety communications.

The new company will be headed by Makoto Endo.

Surge protectors

Surge protectors support many apps

Citel's RF family of P8AX surge protectors are appropriate for wireless systems, microwaves, radios, antennas, GPS, satellite systems and broadband applications. They provide protection against lightning surges and electrical transients. Available connectors include N, BNC, TNC, SMA and 7/16. These coaxial protectors feature low VSWR and insertion loss. They are available for 1W–1,000W and for frequencies from dc to 4GHz. Grounding can be done through an external ground screw or a bulkhead mount. Citel's T1 line of surge suppressor protects wireless loop equipment. The compact B280 and B480 units can be mounted inside a cabinet or on a backboard. They are available for one or two T1 circuits; input/output connections are made with screw terminals or RJ45 jacks.

Circle (351) on Fast Fact Card

Surge protector disconnects power

The Powermax8 Tel surge protector from **Panamax** will absorb and reroute the surge energy to ground, or, in the event of a surge over 1,020j (joules), it will disconnect power to the equipment. Eight protected ac outlets are spaced to accommodate transformers; four outlets are always on, and four are switched. The surge protector includes EMI/RFI noise filtration and a diagnostic light to indicate proper grounding. Its ac protection circuit has a 200V clamping level with instantaneous response time. The unit has a UL 1449 rating of 330V on all three legs of power.

Circle (352) on Fast Fact Card

Surge supressors offer protection to 2,850j

The Isobar and Isotel surge supressors from **Tripp Lite** combine metal-oxide varistors, MOVs and toroidal balanced choke technology, to provide surge protection of as high as 2,850j (joules). Their isolated filter banks prevent interference between connected equipment, eliminating lockups, data errors and audio/video static. All models meet new UL 1449 (1998 revision) standards; most feature all-metal housing. Sinewave tracking yields <35V of surge let-through. Tel models feature built-in RJ11 jacks for modem/fax protection. Ultra models feature diagnostic LEDS to alert users to power problems. The company also offers the IBar line of rack-mount suppressors, which uses just 1U (19 inches) of rack space.

Circle (353) on Fast Fact Card

Protection options feature 100 configurations

Joslyn's range of ac surge protection options includes more than 100 standard product configurations. These devices range from 360kA-per-phase units for central office or hut/shelter applications, to compact, 40kA-per-phase units for lower exposure or lower-risk applications. The products offer MOV or SAD technology, plus remote monitoring and modular design. A line of custom, open-frame ac surge protectors reduces voltage let-through and simplifies system maintenance and integration.

Circle (354) on Fast Fact Card

Voltage regulator provides surge protection

The **Samlex** SEC 400 automatic voltage regulator/line conditioner offers surge protection to assist in eliminating problems caused by excessive voltage fluctuations. Electronic relay controls provide transfer times of less than 0.5 seconds. The 500VA unit provides sinuous output voltage without distortion. Four output receptacles are located on the back of the low-profile cabinet, which

measures 3¼" × 7¼" × 8".

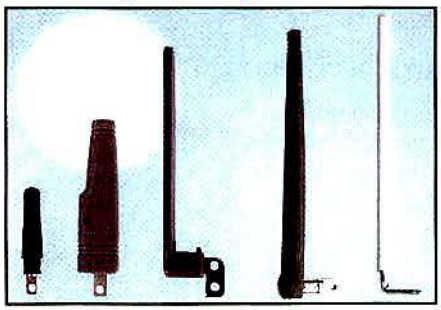
Circle (355) on Fast Fact Card

Isolator protects PSAPs from lightning

Positron's Teleline Isolator provides 65,000V of isolation. The isolator is designed to protect PSAPs. Using a combination of fiber-optic and electromagnetic couplers, it creates a physical break in the copper continuity of the telephone line while maintaining full, uninterruptible communications. It protects critical circuits from the effects of a lightning strike. The isolator adds protection against service interruptions and helps to ensure that an emergency call will not be disconnected in progress. It prevents hazardous voltages from passing through communications equipment and provides complete isolation.

Circle (356) on Fast Fact Card

Antennas represent a compact option



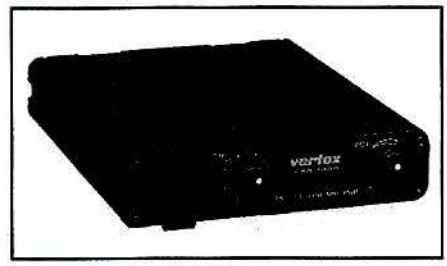
The PM series of permanent-mount antennas from **Antenna Factor** is a line of 1/4-wave antennas designed to mount directly to a product's PCB. The series is appropriate for OEM applications that require a compact, cosmetically attractive, low-cost antenna design. The antennas are available in standard or custom frequencies within a 260MHz to 2.4GHz range. Swivel and tilt functions allow flexibility in mounting and packaging. Customer colors and logo options are available for volume OEM orders.

Circle (401) on Fast Fact Card

READERS' CHOICE

Of the new products in the August 1999 issue, this one generated the biggest reader response. For more information on this product, circle the corresponding Fast Fact number on the card found in the back of this issue, and mail the card to us.

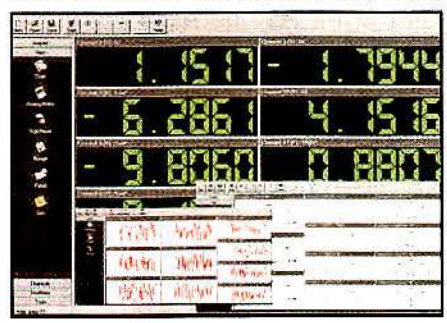
Repeaters enhance comm systems



The VXR-1000 series of vehicular repeaters from **Vertex Radio Communications** is designed to enhance public safety and industrial communications systems. The multichannel crossband vehicular repeater provides portable coverage throughout the system without the addition of site equipment. The repeater allows coverage using the high output power of the mobiles. Small in size, and with true plug-and-play capability, the repeater will interface with most brands of mobile radios. The frequency range is 150MHz–174MHz and 45MHz–470MHz. It has a 16-channel capacity and 5W power output (selectable 2.5mW, 1mW and 500mW power levels). The bandwidth is 12.5kHz/25kHz and features CTCSS/DCS encode and decode.

Circle (500) on Fast Fact Card

Software assists in SCADA applications



Analog & Digital Peripherals' (ADPI) Easi Daq software can be used for acquiring, storing, displaying and analyzing data in a graphical method. The data acquisition software will acquire data from one to 16 channels and then display it in real-time mode with a sampling rate as fast as 1kbps. Data can be imported directly into Excel and other Windows applications. Input options include RS-232, PCMCIA, data acquisition cards and USB. Thermocouples, RTDS, accelerometers, strain gauges, load cells and 0mA to 20mA current are among the typical services supported by Easi Daq. The software supports Windows CE, Windows 95/98, Windows NT and Linux.

Circle (402) on Fast Fact Card

Receiver captures, logs paging traffic

The Fox Paging Receiver from **Berkeley Varitronics Systems** is designed for capturing and logging paging traffic. It supports frequencies at 928MHz–941MHz, 450MHz–465MHz or 145MHz–165MHz. Flex demodulation (four-level) runs as fast as 6,400bps; POCSAG demodulation is as fast as 2,400bps. Based on the original Fox receiver, the unit's hardware continuously detects and demodulates all supported paging formats. The unit captures and logs all paging traffic, measures and logs RSSI, and scans through user-specified frequencies. This handheld, battery-powered unit also offers PCMCIA storage and a fast-charge function.

Circle (403) on Fast Fact Card

Synthesized radio avoids busy channels

The Microtalk 99-channel synthesized radio from **Advanced 2-Way Products** features digital tone-coded squelch and a user-selectable scan to lock out or avoid busy channels. The channels guard and private line allows for compatibility with most brands of two-way radios using digital tone code technology. The hand-held unit, which measures 4 1/4" × 2 1/16", is equipped with a belt clip, 600mAh battery, 110Vac wall charger rubber duck antenna and wrist strap.

Circle (404) on Fast Fact Card

Charging current adjusts to feedback

Advanced Charger Technology's next generation of its Icharge line of intelligent chargers provides a fast-charge, user-friendly interface and extended battery life with no memory effect. The product incorporates "Enrev" technology, which is based on a process known as Dynamic Electrochemical Waveform (DEW). This is a technical method of describing the proprietary method that uses real-time feedback to dynamically alter the charging current in response to a battery's condition.

Circle (405) on Fast Fact Card

Encoder/decoder offers group decode

Midian Electronics' Plectron encoder/decoder, the UED-1P, encodes and decodes the Plectron two-tone format and other two-tone formats. The product is appropriate for use by fleets used by taxi companies, fire departments and police departments. Features include Selcall, group call, deadbeat disable and leading and/or trailing ANI. It also offers group decode on the first and second tone for Motorola Two Tone and group decode on the first and second tone for Plectron. The UED-1 series can handle other formats, including five tone, DTMF and pulse tone.

Circle (406) on Fast Fact Card

Recorder serves public safety needs

The DVR-8 digital voice acquisition recorder from **JEI** is a stand-alone unit for instant recall and archival recording of audio communications. Applications include public safety communication recording, voice logging for order entry, operator training and gathering audio intelligence. Eight recording channels offer simultaneous feedback. Other features include a built-in button key panel, a standard PC keyboard for initial setup, and search and retrieval of voice recordings by date, time and channel options.

An impact-resistant, high-resolution, five-inch monochrome display simultaneously shows information on 18 recordings. This freestanding unit can be used on the desktop or it can be mounted in an EIA-standard 5 1/4" × 19" rack space.

Circle (407) on Fast Fact Card

Antennas support heavy UHF traffic

A new line of UHF omnidirectional antennas from **Antenna Products** includes unity-gain 3dBd and 6dBd models. These products are developed for areas where tough, extreme weather conditions are common. The antennas, available with frequencies of 508MHz–420MHz, 41MHz–450MHz, 470MHz–490MHz and 490MHz–512MHz, can be ordered with 0° to 6° downtilt for mountainous regions.

Circle (408) on Fast Fact Card

Headset enhances restaurant services

Protech's portable two-way communications system is for restaurant employees using its headsets with **Kenwood Communications'** Protalk radios. The system is applicable for service in most restaurants, even in fine-dine establishments, where the wait staff and management can use a concealed-style headset. The system is available with the Manager over-the-ear style or the Procom 5. The Protalk radio features a heavy-duty aluminum chassis and a range of user features.

Circle (409) on Fast Fact Card

Weather-alert radios provide 24-hour updates

Weather-alert, portable radios from **Wireless Marketing** receive around-the-clock updates from the National Oceanic and Atmospheric Administration (NOAA), which broadcasts from more than 480 stations. The WX-67 radio uses Specific Area Message Encoding (SAME) technology that directs NOAA Weather Radio to a specific county or portion of a state. The Coleman NOAA model WX-57 is a small, portable weather radio. It includes all seven NOAA channels and three marine channels. This model features a backlit LCD, lockout, visible/audible signals and battery-level indicator.

Circle (410) on Fast Fact Card

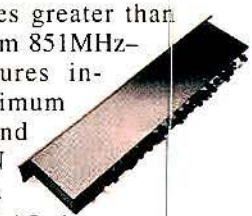
Hand-held device performs criminal inquiries

Datamaxx Applied Technologies, in cooperation with the Memphis Police Department, is testing a pager-sized device that allows front-line law enforcement officers to run critical information inquiries on persons, articles, guns and vehicles. Cyberforce, which measures 3.5" × 2.5" × 0.93" and weighs less than four ounces, hooks to the officer's belt for easy access. Officers can use the miniature keypad to conduct 90% of the queries that are most frequently required during patrol, reducing reliance on dispatcher assistance. Officers enter a vehicle identification number, license plate data, driver's license number or other identifying information to gain access to a nationwide data communications network. A response is generated to the request in less than 10 seconds. The Cyberforce project, which is backed by a partnership with Bellsouth Wireless Data, uses paging hardware from Research In Motion (RIM).

Circle (411) on Fast Fact Card

Receive unit selectively filters SMR channels

Narda West's AMPS receive filter, the AFB-21A-8284-07, provides selective channel filtering in the SMR transmit band. It is designed to pass the AMPS A-Band receive frequencies of 824MHz–846.5MHz, making it appropriate to notch out interference caused by SMR transmit channels. The filter provides greater than 60dB rejection from 851MHz–1,000MHz. Features include 1.3dB maximum passband loss and standard type N female connectors.



Circle (412) on Fast Fact Card

Connectors/adapters meet Part 15 specs

RF Connectors' line of TNC connectors meet FCC Part 15 regulations by incorporating reverse, or left-hand, threads. Standard coaxial connectors will not mate with these interfaces, which meets the compliance regulations. Reverse-threaded TNC males include the RT-1203-1X crimp for RG-8X cable; the RT-1200-C clamp and RT-1202-C crimp for RG-58/U; and the RT-1227 right-angle adapter to reverse-thread TNC female. Reverse-threaded TNC females include the RT-1208 right-angle PCB mount with die-cast metal body; the RT-1209-B right-angle PCB mount with ABS body; the RT-1211-1 bulkhead with solder cup; and the RT-1226 barrel adapter with reversed threads at both ends. All connectors and adapters feature nickel-plated bodies, and gold-plated pins and contacts. Other reverse-thread connectors are available with BNC, N and SMA interfaces. For reverse-polarity or gender requirements, the RP series of connectors and adapters is available with BNC, N, TNC and SMA interfaces.

Circle (413) on Fast Fact Card

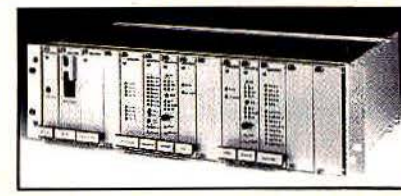
Docking stations support MDC use

The NP-UPR-24 universal in-vehicle port replicator from **Gamber-Johnson** allows fleets to use different mobile computers in the same vehicle. It includes one docking station that can be used with multiple upgrades and computers. By plugging the dc power adapter and the provided USB connector cable into the modem, a user establishes full power to the computer and all peripherals. An internal power supply provides the correct current to the USB hub to maintain USB compliance. The width is adjustable from 10.3" to 13.6". Optional accessories include microphone bracket, mobile phone mount bracket, LED light assembly, PCMCIA card guard and a Palm Pilot/Workpad mount bracket.

Circle (414) on Fast Fact Card

DSP system protects power equipment

The **Iniven** PTR-1500 communications system aids in protecting electric power generation and transmission equipment. Single- and dual-channel FSK modulation techniques are used with digital differential guard/tip energy sensing. The unit's operating characteristics are controlled by firmware. Parameter changes, such as frequencies, channel bandwidths, logic schemes and communications protocols are completed by changing DIP switch settings. Crystal-controlled

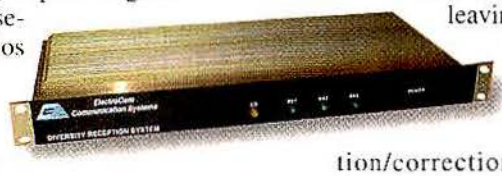


digital signal processing (DSP) technology aids in generating the transmitter frequency, establishing receiver frequency discrimination and managing all channel filtering.

Circle (415) on Fast Fact Card

System stresses digital error correction

ElectroCom Systems' Invadr is a wireless voice and data transmission system. The system permits almost error-free, two-way transmission of digital voice and high-speed digital data. Invadr's IP series of mobile radios offers simultaneous voice and data transmissions over each radio channel, sending and receiving data at rates as fast as 19.2kbps on 25kHz channels (9.6kbps with 12.5kHz channels). The system provides a 20dB improvement in SNR in low signal-to-noise environment in the UHF (400MHz–512MHz) and 800MHz frequency bands. The voice and data radios are compact, one-piece units that incorporate a modem and digital RF radio. The modem also provides forward-error correction, bit interleaving for more robust data communications and third-generation collision detection/correction functions. The transceiver includes the Intelligent Diversity Reception system, for low BER voice and data communications. For simultaneous voice and data operation, a voice interface is provided for each voice subscriber.



Circle (416) on Fast Fact Card

Paging monitor controls analog/digital inputs

The Protektor+ from **PageTek** monitors eight inputs, each input configurable to function in an analog or digital mode. Two relay outputs are supported. One serial port is available for local VDT/passthrough, and a second port is optionally available for off-board communications. The monitor may be accessed locally via a DB-9 serial port or remotely, via an integrated 14,400bps modem. Analog-configured inputs can monitor positive or negative voltage inputs. Digital-configured inputs can monitor bi-state inputs not adhering to EIA standards, ensuring equipment may be monitored without external interface construction.

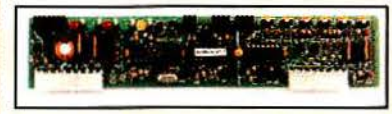
Circle (417) on Fast Fact Card

Battery supports IDEN radio

The M8614 rechargeable replacement battery for the Motorola Nextel IDEN i1000 phone/radio is available from **Multiplier Industries.** This Lithium-ion (Li-ion) battery, rated at 3.6V and 900mAh capacity, is intended as a replacement unit for the Motorola NTN-8614AR. The design of the battery incorporates protective circuitry to provide proper charging of the Li-ion cells.

Circle (418) on Fast Fact Card

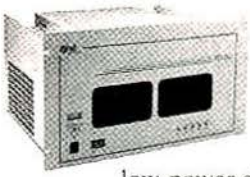
Repeater controller fits GE Mastr II



NHRC has made available the NHRC-4/M2 Repeater Controller, which can be installed in General Electric (GE) Mastr II mobile radios and stations. Repeater operation and control is done via a remote base port. All wiring fits inside the product's case. Mobile radio installation requires adding two wires and severing one trace on the radio's system board before plugging in the controller. For station applications, installation consists of adding three wires and plugging in the unit. Application notes for station for mobile radio modifications are available. The product provides CW ID, ID timer, individual timeout timers for the main and remote ports, and a hang timer. Five different courtesy tones indicate channel activity and remote base status. A digital output, included for control applications, can be configured to activate a fan while the transmitter is on and to keep it running for a specified time afterward.

Circle (419) on Fast Fact Card

Revamped amplifier serves low-band VHF



TPL Communications has completely redesigned its 300W low-band VHF amplifier, which is available in the HMS series. The amplifier's features include SWR protection, low-power alarm, over-temperature alarm, forward- and reverse-power monitoring, forced-air cooling and a self-contained power supply. The design uses 48V MOSFET transistors and surface-mount components.

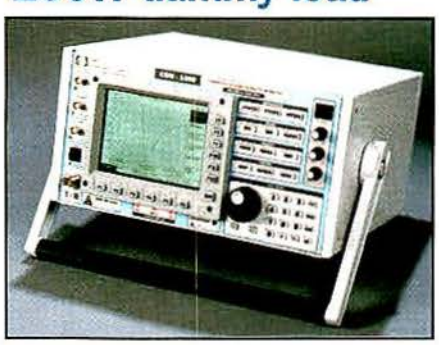
Circle (420) on Fast Fact Card

Upgraded console assists dispatchers

Building on its original platform design, **Com-Net Ericsson Critical Radio Systems** has upgraded its C3 Maestro dispatch console. Status and message functions allow status code sent by a field radio to be displayed as a text message at the console. The request-to-talk feature allows users to visually signal the dispatcher that they want to talk by using status code to display an on-screen text message. Tracking modules provide call history records for each talk group or entity the dispatcher monitors. When patch/simulselect mirroring is enabled, each patch creation automatically creates a corresponding simulselect, and vice versa. With the auxiliary input/output function, a dispatcher can remotely conrol relays and events while receiving visual and audible alerts at the console.

Circle (421) on Fast Fact Card

Service monitor offers 200W dummy load



Link Communications' CSM-1000 service monitor features a digital spectrum analyzer, an RF receiver, a generator, a digital oscillocope and a 200W dummy load.

Circle (422) on Fast Fact Card

Logic board serves Motorola Pro radios

The **SmarTrunk Systems** ST-865M5 logic board is configurable for plug-in installation for most Motorola Pro Series portable and mobile radio models. It offers the company's Omni feature set for large fleet dispatch and multisite roaming applications. The Omni features include multiple channel banks, PTT groups and receive groups; Smartscan, positive radio kill, Turbo Speedial and PC programming with SmarTrunk's Windows-based Optionboard Service Software (OSS). The Smartrunk II digital trunking systems designed for dispatch and telephone interconnect applications below 800MHz. The ST-865M5 is the latest addition to the logic board collection for more than 50 radio models from manufacturers such as Alinco, ICOM, Kenwood, Motorola, Standard and Yaesu.

Circle (423) on Fast Fact Card

Spectrum analyzer monitors RF remotely

The P9116 spectrum analyzer system from **Morrow Technologies** can perform remote monitoring of transmit or receive sites that are located outside a main facility. The analyzer covers the frequency range of 100kHz to 1,600MHz and is packaged in a rugged industrial chassis that includes a power supply, Pentium controller, modem and various serial and parallel communication ports. When used in conjunction with a VGA monitor and the supplied GUI, the unit operates like any other conventional RF spectrum analyzer. When used in a remote monitoring application, the field-located analyzer acts in a "server" mode and can be accessed and controlled from any "client-designated" PC or laptop via RS-232, T1 line or the Internet. The synthesized L.O. is digitally tuned with a 2Hz resolution. Frequency accuracy is ±0.5dB from −120dBm amplitude.

Circle (424) on Fast Fact Card

Microwave radio allows software adjustment

NEC America's 2600 series is an asynchronous, low-to-medium-capacity digital microwave radio. Incorporating a bit-rate flexible modem, the radio allows software-controlled adjustments in bandwidth, accommodating growth and change in the transmission capacity of the radio. The bandwidth flexibility allows the radio to be easily re-deployed within a network, handling bandwidth requirements from 2.5MHz to 10MHz on the same platform. The radio transmits as many as 32 DS1s providing high traffic capacity in a 10MHz bandwidth. The radio offers a drop-and-insert capability at repeater locations, allowing DS1s to be dropped via software control.

Circle (425) on Fast Fact Card

Antenna serves utility AMR data

Hirschmann's disc-shaped antenna is for remote data collection in the utility industry. The model E-6003 has a frequency range of 908MHz–928MHz. It is five inches in diameter and features a low (1.5-inch) physical profile. Polarization is vertical; the antenna has monopole-equivalent horizontal and vertical beamwidths. A radiator system is enclosed in a weather-resistant radome. The antenna also offers a CellNet-compatible radiation pattern.

Circle (426) on Fast Fact Card

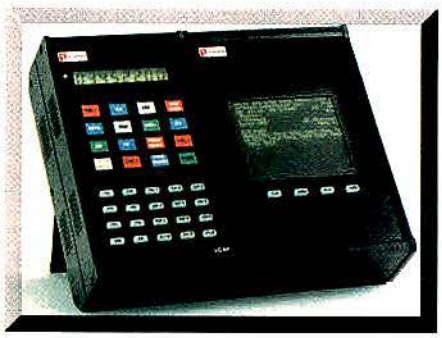
Analyzers reject interference

Anritsu's Site Master cable and antenna analyzers are handheld instruments that feature rejection of interference signals and distance-to-fault measurement capabilities. The "B" series offers higher dynamic range, greater storage capacity of test setups and measurements, and 517 data points that enable identification of faults at a high range. Other features available in the B series include a high-resolution (640 × 480) full VGA display, a field–replaceable NiMH battery that consistently provides 2.5 hours' operating time and enough memory to store as many as 200 measurements that are time- and date-stamped and that can be custom-labeled.

Circle (427) on Fast Fact Card

E9-1-1 module operates through power outage

The E9-1-1 ICM/EL from **Positron** is an intelligent control module with an EL display. System reliability can be enhanced with the product's distributed microprocessor architecture, allowing each display to operate under its own control. The module is programmable to a maximum of 64 voice and data transfer destinations. An optional dc battery mode ensures system operation during a power outage. The product also performs self diagnostics and alerts operators of error conditions. The on-demand ALI allows call-takers to generate hard-copy reports as required. The single-button redial of a disconnected caller is made possible through the re-ring abandoned caller option. The display can recall, on demand, ANI/ALI information for the last ten calls received.



Circle (428) on Fast Fact Card

Tools enhance voice logging system

Dynamic Instrument's Investigator Suite consists of a set of integrated software tools that are available for the DI 936 Pro and DI 939/E digital voice recording systems. The suite includes Xstream audio, a "streaming audio" technology for easy delivery and instantaneous playback of recorded emergency calls on a remote, multimedia Windows 95/98/NT PC. The audio file can be saved to the local hard drive, a floppy disc, CD, or distributed as an email attachment. The Audiomap feature is a playback tool that depicts recorded audio in a graphic format and shows the relative relationship of conversations along a continuous time thread. As many as ten channels can be displayed, and any four can be played simultaneously in synchronized time. Channels may be activated or deactivated during playback for channel isolation, and the 939/E provides individual volume controls.

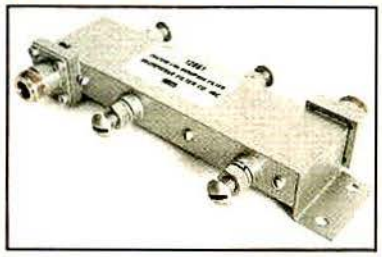
Circle (429) on Fast Fact Card

AVL system selects from multiple media

The V-Track 2000 from **Radio Satellite Integrators** is a third-generation GPS-based vehicle tracking system for fleet management and AVL. The product can use multiple communications media for vehicle data reporting, as well as upgrade to additional media as they are developed. This ability allows the unit to automatically select cost-effective and available means of communications at any given time. The unit can use almost any communications link including: VHF/UHF two-way radio, analog cellular, CDPD, BellSouthWireless Data, CDMA, TDMA and a variety of satellite systems. The product can also be seamlessly integrated to several in-vehicle devices and sensors such as mobile data terminals, laptops, door sensors, navigation devices, odometers and card swipes.

Circle (430) on Fast Fact Card

Filter offers 8MHz μwave bandwidth



The model 12861 from **Microwave Filter** is a single-channel ENG (1,990MHz to 2,110MHz) bandpass filter. This unit has an 8MHz bandwidth, providing less than 3.5dB insertion loss at center frequency. This model offers greater than 25dB rejection at ±7MHz from center frequency, providing selectivity to remove undesired interfering frequencies. It can be provided with either 8MHz or 16MHz bandwidths and additional sections for greater out-of-band rejection. The unit can be modified for outdoor use. Connectors are 50Ω type N female, but other connectors are available.

Circle (431) on Fast Fact Card

Radio backpack supports field operations

The Powerport World Pack from **Cutting Edge Enterprises** lets the user carry his command center on the back with ease. This rugged backpack is designed to carry a mobile radio (as heavy as a 100W station) and rechargeable power supply. It is constructed of laminated heavy-duty black nylon with ¼" foam padding. The construction is sturdy and weather-resistant. The radio is secured in the upper compartment in an adjustable radio sling that allows the unit to be raised or lowered for access. A lower compartment is designed to hold a rechargeable battery power supply. The lid has a pocket for microphone storage. The pack can be carried on the back with body-contoured shoulder straps, or carried by the handle at the top. A mobile antenna fits in a side pocket with easy-access straps securing the upper portions. The radio is easily recharged by ac, dc or with optional roll-up solar cell charger.

Circle (432) on Fast Fact Card

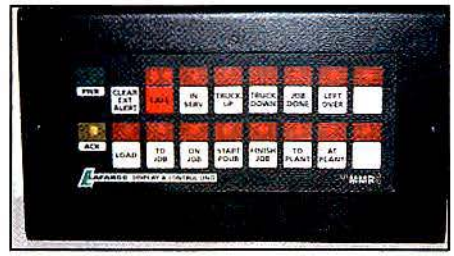
Workstations extend wireless coverage

The **Itronix** X-C 6250 Pro and T5200 mobile workstations feature Sierra Wireless' SB300 CDPD modems and support the Airbooster 350, an intelligent RF amplifier that works closely with the integrated CDPD modems. Public safety users can extend their wireless coverage by several miles by automatically switching between an integrated antenna and a vehicle-based antenna, as they remove or insert their mobile workstation into Itronix' vehicle cradle. The auto-switching antenna option will increase radio coverage performance and avoid coverage losses that result from transmitting data from inside a vehicle. The workstations amplify transmit power from a portable 0.6W to a mobile 3W output. Mobile workers can instantly switch from the integrated CDPD antenna to a vehicle antenna. The integrated CDPD modem, based on the energy-efficient SB300 series, features a standard serial interface, low current drain, broad temperature and vibration specifications, and a PCCA-compliant host interface.

Circle (433) on Fast Fact Card

Dispatch terminal suits harsh conditions

Baron Communications' BMDT dispatch terminal is a status/message terminal that can be configured for various host software interfaces. The durable buttons are backlit for easy viewing. The rugged design makes it suitable for use in harsh environments such as construction, forestry and mining. The unit is GPS/AVL-capable and offers a throughput of 9600 baud. The back of the unit has an RS-232 port for interfacing with various mobile radios.



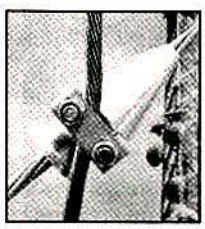
Circle (434) on Fast Fact Cards

Paging communicator features 'e-connect'

Extended Systems and **Motorola** are offering short-range wireless connectivity and e-connect technology to Motorola's Timeport P935, an interactive paging communicator for mobile business users. The communicator's e-connect technologies combine e-messaging (word messages passed via the Internet or telephone dispatch) and e-talk (the ability to send messages to one-way pagers, to and from two-way pagers and to most email accounts). The communicator is also a personal information manager (PIM). Users can "e-connect" to select corporate or personal databases wirelessly and access mission-critical information real-time via an Internet link.

Circle (435) on Fast Fact Card

Ground wire attachment prevents ice damage



The **ERI** Guy Guard attaches an electrical grounding wire to a guy wire, and provides guy-wire grip protection from ice damage. The ground wire attachment averts galvanic corrosion between copper grounding wire and guy wire. It also reduces electrical resistance between grounding wire and guy wire and eliminates point-load stress to guy wire. The attachment prevents ice damage to grounding wire and guy-wire grip, and it prevents tower failure. The attachment is stainless steel and machined for close guy-wire tolerance and fit. It also offers an easy, single U-bolt attachment.

Circle (436) on Fast Fact Card

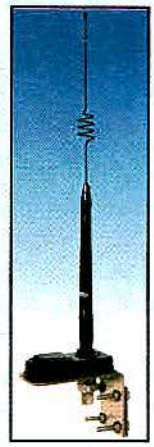
Cabinet racks offer custom features

Bud Industries has introduced its Luxor series of cabinet racks, available in two styles and a variety of sizes and configurations. All models feature fully adjustable, extruded aluminum-panel mounting rails, internal cable-management bars and gasketed doors. They are available with either acrylic front doors for instant monitoring of internal components or with extra-wide cabinets to allow for additional cable access. All Luxor cabinet racks meet EIA-310 and IEC-297 standards, and can accommodate 19" equipment. All units are fully assembled.

Circle (437) on Fast Fact Card

System combines cell/GPS antenna

The model ASPD913TGPS Tele-Locator from **Antenna Specialists** is a dual-system cellular/GPS antenna. It combines active GPS location with two-way communications into a mirror-mounted antenna. Applications include E9-1-1 cellular solutions, tracking programs and long-haul trucking. The product's ground-plane-independent design allows installation on mirror supports on the side of a vehicle when a rooftop antenna cannot be installed. An ultrasonic weatherproof seal protects the GPS engine against extreme weather. The antenna covers 824MHz–894MHz cellular and 1,575.42MHz GPS.



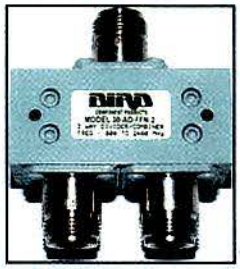
Circle (438) on Fast Fact Card

Headset includes optical switch

The Cordless XLT phone headset from **Hello Direct** features an optical switching mechanism. The noise-free switch, located inside the mic boom of the headset, is used to turn the headset on and off, and to mute the mic. When the Readiline remote answering device is installed, the user can answer a call remotely by swinging the mic boom down. The headset signals the Readiline to lift the handset on the user's phone to connect the call.

Circle (439) on Fast Fact Card

Divider offers reliable matching



The model 30-AD-FFN-2 two-way divider and combiner from **BCP** offers reliable matching with less than 2° phase (typical 0.5°) and less than 0.5dB amplitude. This 30W divider and combiner has a frequency range of 800MHz to 2.4GHZ with insertion loss of less than 0.5dB. Other specifications include isolation greater than 25dB minimum (J2 to J3) and VSWR of 1.20:1 maximum. Connector options are type N female and SMA female.

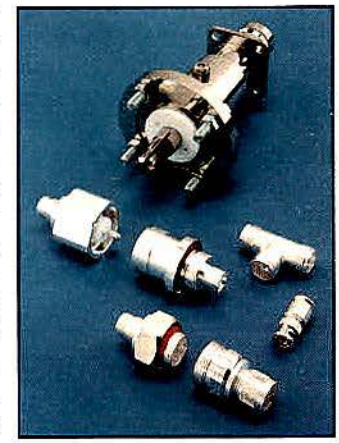
Circle (440) on Fast Fact Card

Modem suits public safety apps

The 3W modem from **Novatel Wireless** is appropriate for applications in public safety, automatic vehicle location (AVL) tracking and telemetry. This rugged product uses CDPD technology. Designed to operate in harsh environments, the modem can tolerate vibrations and wide temperature ranges, and provides data transmission in extreme weather conditions and various mobile environments. The 3W unit can accommodate 9V to 30V of vehicular input power. It is bundled with Opcenter, a Windows interface that allows for simple configuration, operation and monitoring. It also features a sleep mode, which maintains network connections at low battery levels.

Circle (441) on Fast Fact Card

Adapters help interface problems



Tru-Connector's RF coaxial adapters can help almost any interface problem including compatibility between large to small series connectors and incompatible plugs, jacks and receptacles. Applications include adapting to more common interfaces, hardware transitions, changing cable run directions and sizes, and converting standard connectors into quick-disconnect types. The adapters can include LC to N, LC to QDS, LC to N, QDM to BNC, and many other combinations. Materials, back-end plating, insulators and gaskets can be specified. Standard tooling exists for more than 100 types of connectors with interfaces per MIL-C-389012 and MIL-STD-348 standards.

Circle (442) on Fast Fact Card

Analyzer IDs complex interference

Summitek Instruments' Basestar interference analyzers protect specific license uplink/reverse telecommunications channels (824MHz–849MHz and 1,850MHz–1,910MHz). The analyzer monitors the protected-band and potential-interference sources located between 50MHz and 2.0GHz. It can identify interference generated by a single emitter and more complex interference generated by the interaction of two independent emitters. When an offender is identified, it provides information about the source of the emission, including the offending company's name, location, transmitter characteristics and the interference mechanism.

Circle (443) on Fast Fact Card

Emulator extends frequency range

Telecom Analysis Systems' 4600AH noise and interface emulator extends frequency coverage to 2.5GHz. This capability makes the 4600AH capable of testing next-generation wireless equipment that operates in the PCS, IMT2000 and 2.4GHz ISM bands. The product conducts carrier-to-noise (C/N) and carrier-to-interference (C/I) tests. It can accommodate precision C/N characterization for such wireless devices as PCS handsets and base stations, mobile satellite handsets, wireless local loop (WLL), wireless LAN, smart antenna systems and 2.4GHz ISM-band transceivers. The device measures an incoming RF signal, then adds the specified amount of AWGN or interference to obtain a desired C/N or C/I ratio. It is available in single- and dual-channel configurations. The included software, Taskit/4600 for Windows, facilitates test setup and control. Although predefined configuration files based on industry standards are incorporated into the software, users also can create custom configurations.

Circle (444) on Fast Fact Card

PEOPLE

Com-Net Ericsson Critical Radio Systems, Lynchburg, VA, names its board of advisors, including:

George Allen, former governor of the Commonwealth of Virginia and a member of the U.S. Congress; **Haley Barbour,** former chairman of the Republican National Committee; **Barbara Hackman Franklin,** former U.S. secretary of commerce and director of the Nasdaq Stock Market; **Gerald Griffin,** former director of NASA's Johnson Space Center; **James Howard,** chief executive of Northern States Power Company; **Bob Miller,** former governor of Nevada and former chairman of the National Governor's Association and Democratic Governor's Association; **Brian Mulroney,** former prime minister of Canada; **Edward Rendell,** general chair of the Democratic National Committee and former mayor of Philadelphia; **Oliver "Buck" Revell,** former deputy director of the FBI, president of the Institute for the Study of Terrorism and Political Violence, Chairman of the Greater Dallas Crime Commission, and life member of the International Association of Chiefs of Police (IACP); **Samuel K. Skinner,** former White House chief of staff, secretary of transportation and president of Commonwealth Edison; and **Dewey Stokes,** former president of the International Fraternal Order of Police

Sheila Malone, director of Elkhart County 911, joins Castle Hayne, NC–based Vision Software's Software Advisory Board (SAB).

Guy Campbell, group president for the wireless and in-building products group at **Andrew,** Orland Park, IL, is elected president.

Changes at JBRO Batteries, Lisle, IL:

Charles Pokonosky departs TDI Battery, Downers Grove, IL, as director of OEM sales development and leadership to join JBRO as vice president of OEM sales. **John Brophy Jr.** fills a newly created position as vice president of LMR sales after managing JBRO manufacturing, finance and operational areas. **Jean Rohrscheib** joins JBRO as manager, customer service, after ten years of customer service, sales and operations experience.

Joan E. Ryan, departs Alliant Foodservice, Deerfield, IL, as senior vice president, to join Tellabs, Lisle, IL, as chief financial officer.

Edwin K. Walters joins Larus, San Jose, CA, as chief financial officer after leaving the Umbra Group, Palo Alto, CA, as a financial manager.

Al Forsyth joins Hark Systems, North Charleston, SC, as sales and marketing manager after working as regional director for Budget Rent-A-Car and starting up the U.S. Franchise Sales Division for NCR, Dayton, OH.

Mitch Stone leaves Datum, Irvine, CA, as vice president of sales and marketing, to join IFR Systems, Wichita, KS, as vice president of sales, Americas Region.

Will Daugherty departs Seaward International, Clearbrook, VA, as director of marketing, to join Lawrence Behr Associates, Greenville, NC, as director of product marketing.

CLASSIFIED

Dawn Rhoden
Classified Advertising
Manager

Reserve your spot in the next issue!

Phone: 913-967-1861
800-347-9375
Fax: 913-967-1735

Mail: 9800 Metcalf Ave.,
Overland Park, KS 66212

Category Index

professional services

FREDERICK G. GRIFFIN, P.C.
2938 Warlick RD
Lynchburg, VA 24502
(804) 237-2044
NATIONWIDE COMMUNICATIONS CONSULTING
Mobile Radio, Microwave, E9-1-1,
CAD, Paging, LAN,
Dispatch Communications Centers
Multi Site Propagation Analysis

HERB SACHS, CONSULTING
Specialist in Public Safety Communications
P.O. Box 729
Bowie, MD 20715
301-464-4268

MCCON
Mobile Communications Consulting
S.R. McConoughey, P.E.
Principal
13017 Chestnut Oak Drive
Gaithersburg, MD 20878 (301) 926-2837

OMNICOM, Inc.
COMMUNICATIONS ENGINEERING
GENE A. BUZZI
PRESIDENT
930 THOMASVILLE ROAD, SUITE 200
TALLAHASSEE, FLORIDA 32303
PHONE: (850) 224-4451 • FAX: (850) 224-3059
E-mail: omnicom@omnicom-usa.com

SCHWANINGER & ASSOCIATES
Attorneys at Law
Robert H. Schwaninger, Jr.
1835 K Street, NW, Suite 650
Washington, D.C. 20006
(202) 223-8837
rschwaninger@sa-lawyers.net

GE PORTABLE SERVICE
- FAST TURN
- WARRANTY
- $48.00 hr./2 hr. MAX
- PARTS GE LIST
- RETURN UPS PAID

Smith Communications Service
2121 W. Parrish Ave., Owensboro, KY 42301
270-683-0936

TROTT
COMMUNICATIONS GROUP
RAYMOND C. TROTT, P.E.
Chairman
1425 Greenway Drive, Suite 350
Irving, Texas 75038
972/580-1911 • Fax: 972/580-0641

THE PORTABLE DEPOT, Inc.
KEEPING AMERICA COMMUNICATING FROM COAST TO COAST!
• FACTORY TRAINED TECHNICIANS •
• SURFACE MOUNT TECHNOLOGY •
• FACTORY APPROVED NATIONWIDE •
• EDACS & AEGIS •
• VOICE GUARD CERTIFIED •
• MPD, MPA, TPX, PCS AND ALL CURRENT PRODUCTS •
Route 2, Box 338C • Lynchburg VA 24501
ERICSSON 804-237-3427

PORTA-TECH **PORTABLE TECHNICAL SERVICE, INC**
121 Crowell Lane • Lynchburg, VA 24502
FACTORY TRAINED TECHNICIANS FOR QUALITY SERVICE
ERICSSON
GE Portable Radio Service Depot
Factory Approved Nationwide
- Current Product Lines
- Voice Guard Certified
- Public Service Trunking
- Surface Mount Technology

(804) 239-3049

prof. consultants

Engineering For The Wireless World
Wireless Communications Systems and Facilities
Define Acquire Build Manage
Design Zone Test Operate
RCC Consultants, Inc.
100 Woodbridge Center Drive, Suite 201
Woodbridge, NJ 07095
800-247-4796
email - info@rcc.com
Offices Nationwide & International
Circle (101) on Fast Fact Card

employment

Communications Technicians
Central NJ based Communications Company looking for experienced Field Service Technicians. Applicants must have experience in Motorola Consoles, Trunking, Voting systems and all other aspects of the field service business. FCC license, PCIA or NABER certification preferred. Salary commensurate with qualifications and experience. Fax or mail your resume to:

Quality Communications
Attn: Service Manager
1985 Swarthmore Ave.
Lakewood, NJ 08701
Fax: (732)730-9005
info@qualitywireless.com

QUALITY COMMUNICATIONS

Public Safety Wireless Technology Decisions?

QRC
Quantum Radionics Corporation

Wireless & Information Technology Consultants

Today, Public Safety Officials face major decisions in selecting which wireless and information technologies will best serve agency needs today and in the future. QRC is the first step in identifying the right solutions.

At QRC, we provide competent, unbiased technical advice concerning the full range of available technologies to support your critical public safety missions.

QRC's approach is simple yet effective: We work with your staff to define your agency's needs, and then identify candidate technological solutions.

QRC is ready to assist your agency throughout the entire life cycle of your public safety technology project-from the planning of a new communications center through the implementation of digital trunked radio system, E911, CAD, and records automation.

QRC provides expert technical and programmatic support in:

- Budget Planning and Execution
- Cost/Benefit Analyses
- Technology Evaluations
- System Specifications. Planning, and Design
- System Implementation Oversight
- Training Program Development
- System Troubleshooting and Optimization

Does your agency require privacy protected wireless communications? Is the security of your information and databases important? Do you need mobile computing today or in the future? Is NCIC 2000 right for your agency? Should you implement a Project 25 digital wireless system? How can commercial wireless services leverage your agency's limited financial resources?

QRC will work with your agency to address these questions and other technology issues in all areas including:

- Integrated Digital Voice and Data Technologies
- Emerging Wireless Technologies
- Project 25 Digital Communications Systems
- NCIC 2000 Technologies
- Commercial Services, such as CDPD and 3G Wireless
- Trunked, Conventional, and Rapid Access Trunked Systems
- Simulcast and Mobile Computing
- Communications Operations Center Design
- Coverage and Propagation Studies
- Enterprise Networking
- Intelligence Analysis Automation
- Information Security and Privacy Protected Systems
- Surveillance and Title III Technologies

For information on how QRC may assist your agency in its Public Safety Technology decision process, contact us at: Quantum Radionics Corporation, 2121 Eisenhower Avenue, Suite 200, Alexandria, VA 22314, Voice: 703.684.8548; Telefax: 703.684.9505; e-mail us at info@quantum-radionics.com or visit us at www.quantum-radionics.com

- Advancing Technology Through the Millennium -

Circle (100) on Fast Fact Card

Vertex Standard

Due to rapid growth and expansion, this leading manufacturer in the communications industry is seeking to add additional management staff to accommodate our rapid growth. Successful candidates should have broad experience with exceptional management and supervisory skills in the following areas:

Land Mobile Sales
Customer Service
Technical Service

Vertex Standard, the Land Mobile Radio division of Yaesu USA, offers an excellent compensation and benefit program. For consideration, please forward your resume, with salary history/requirements to:

Human Resource Department
Vertex Standard Communications
17210 Edwards Road
Cerritos, CA 90703

WIRELESS STAFFING SPECIALISTS
ALL LEVELS OF POSITIONS FILLED GLOBALLY
• Technicians • Engineers • Managers • Sales
Send resume to address below
Check web page for immediate openings
WWW.PERSONNEL1.COM
PERSONNEL RESOURCES, INC
Since 1989
P.O. Box 14570, Cincinnati, OH 45250
E-Mail, Carecrcom@AOL.com
606-491-5410 FAX 606-491-4340

equipment for sale

All CCII Labels
WHITE, ORANGE, GREEN AND RED BUTTONS AVAILABLE
$12.50 ea
CCII PROGRAMING AVAILABLE
ORDERS SHIPPED IN 14 DAYS
NORTHEASTERN
Communications, Inc.
Waterbury, CT (203) 575-9008

equipment for sale

STATION IDENTIFIERS
- ❑ Morse code and Voice Identification
- ❑ Three monitors and three timers
- ❑ Several Standard Models available
- ❑ Reseller and Quantity Discounts

RACOM PRODUCTS, INCORPORATED
800-722-6664
216-351-1755

TRINITY RADIO
USED RADIOS *at Low Prices!*
- MICOR
- MITREK
- PORTABLES
- MOCOM 70
- MAXAR
- RPTRS
- GE
- RCA
- ACCESSORIES
- TONE ELEMENTS
- CHRYSTAL ELEM.
- BASE STATIONS

(940) 433-5452 • trinity-radio.com

DTMF/encoders

STEEL KEYS
SEALED GOLD CONTACTS

An ultra high quality DTMF Encoder for absolute reliability and function.

- Contacts are: Water Proof / Dust Proof
- Completely Self Contained — No RFI
- Simple 3-Wire Connection • Output Level Adj
- Wide Operating Range 5 to 16vdc
- Wide Temperature Range -22°to +160°F
- Supplied with Instructions, Schematic, Template & Hardware

Call or Write for Free Catalog

PK-1 $71* / PK-1K $78* W/Relay
VISA/AMEX
*Request Quantity Price
PK-2 $76* / PK-2K $83* W/Relay
We've moved!

Mail Order To:
Pipo Communications
Emphasis is on Quality & Reliability
1516 Cassil Place
Hollywood, CA 90028-7106
Tel: 323-466-5444
Fax: 323-466-1520

Circle (101) on Fast Fact Card

SAVE BIG BUCKS ON
Used 2 Way Radio
MOTOROLA • GE • EF JOHNSON etc.
PORTABLES / PAGERS / MOBILES / BASES / REPEATERS
Contact us when you are looking for economical used equipment. We are a reliable source for all major brands of used 2 way gear
(708) 681-0300
Buy • Sell • Trade
Visit our web site: WWW.MDMRADIO.COM
or E-Mail us at mdmradio@earthlink.net
MDM Radio Ltd.
1629 N. 31st Ave. Melrose Park, Il. 60160
Tel. (708) 681-0300 Fax (708) 681-9800

WHY PAY MORE

Air Comm: First in Quality – Price – Selection – Satisfaction

RECENT ARRIVALS

Portable Radio Accessories:

MOT 6 UNIT RAPID CHARGER FOR: SABER, HT1000, HT750, HT600, GP300 (N.O.S.), P100/HT90, SP50, P50, VISAR, &MX		CALL
MOT SABER 6-SLOT INSERT (01-05952P83)	N.O.S.	25
MOT HT600 SERIES SPEAKER MIC (NMN615)		40
MOT SABER SPEAKER MIC (NMN6128C)	N.O.S.	60
MOT HT1000 SERIES SPEAKER MIC (NMN6193)		4
MOT MT500 SPEAKER MIC (NMN6082)	N.O.S.	50
STD SPEAKER MIC (CMP50)	N.O.S.	15
MOT HT1000 SURVEILLANCE MIC (BDN6668)		60
MOT GP300 EARPIECE (HMN9725)		25
MOT HT600 3" BELT CLIP KIT (REX4023)	N.O.S.	5
MOT SABER III HOUSING (NHN6418)	N.O.S.	75
MOT ASTRO SABER HOUSING (NHN6544)	N.O.S.	75
MOT VARIOUS PORT TO EXT'L ANTENNA ADAPT.	N.O.S.	5
MOT RVN ANTENNA KIT	N.O.S.	15
MOT HT600 CARRY CASE W/SWIVEL (NTN5460)	N.O.S.	25
MOT SABER CARRY CASE (NTN677SP2)	N.O.S.	20
MOT MT500 OMNI CARRY CASE (NLN6686)	N.O.S.	20
MOT MX CARRY HOLDER (NLN4120)	N.O.S.	15
MOT VHF ANTENNA (NAD SERIES)	N.O.S.	4

Mobile Radio Accessories:

MOT MCS EXT'L SPEAKER 13W (HSN4023)	N.O.S.	30
MOT MAXTRAC EXT'L SPEAKER (HSN9326)	N.O.S.	20
MOT MAXTRAC AMPL EXT'L SPEAKER (HSN1000B)	N.O.S.	35
MOT SYNTOR-X SERIES SSM (TS171D)	N.O.S.	50
MOT MARATRAC 99F CONTROL HEAD (HCN1089/90)		CALL
CELLWAVE MOBILE DUPLXR VHF (MOT HFD8465)	N.O.S.	200
CELLWAVE MOBILE DUPLXR UHF (MOT TDN7407)	N.O.S.	200
CELLWAVE MOBILE DUPLXR UHF (MOT RFE4000)	N.O.S.	200
P/D MOBILE DUPLEXER UHF W/BNC (633-6)		125
SINCLAIRE MOBILE DUPLXR 800 MHZ (MR454)		40
MOT ANTENNA KIT VHF TRUNK LIP (HAD4011)	N.O.S.	12
MOT ANT KIT UHF 403-450MHZ TRUNK LIP (RRA5549)	N.O.S.	12
MOT ANTENNA KIT UHF UNITY (TAE6052)	N.O.S.	10
MOT ANT KIT UHF 3.5db GAIN LIP MOUNT	N.O.S.	20
MOT ANTENNA KIT 800MHZ UNITY (HAF4002)	N.O.S.	7
MOT ANTENNA KIT 800MHZ GAIN (RRA48B3)	N.O.S.	14
MOT VARIOUS TRUNK LIP MOUNT (01-80355A-SERIES)	N.O.S.	CALL
MOT LOW BAND SPRING BASE ANT MOUNT (TAB 103-)	N.O.S.	25
MOT LOW BAND SPRING BASE ONLY	N.O.S.	10
EFJ MOBILE SPEAKER (250-0151-006)	N.O.S.	15
EFJ AVENGER MOBILE SPEAKER (585-5030-018)	N.O.S.	10
RACOTEK WIRELESS MODEM 800MHZ LTR (901-4480)		20

Base Station Accessories:

MOT TEST EQUIPMENT CARRY CASE/2400 (RTL4115A)	N.O.S.	100
MOT TEST EQUIPMENT CARRY CASE/R1033 (01-80389A6)	N.O.S.	25
MOT R1033 TEST SET W/CABLES		200
MOT DAPICOM 9000-2 DATA RADIO SYSTEM (FM-2 / FP-2)		CALL
MOT FLEXAR REPEATER UHF 15W PL		300
MOT MICOR 470-494MHZ 100W PA (TTE1694)	N.O.S.	300
MOT MICOR 136-150/162-174MHZ 100W PA (TLD 1692/94)	N.O.S.	250
MOT MICOR 30-36/36-42MHZ 100 W PA (TLB1412/13)	N.O.S.	200
MOT MSF5000 METER PANEL (TLN2418) *CLEARANCE*	N.O.S.	100
MOT MSF5000 DIAGNOSTIC PANEL (TLN2419) *CLEARANCE*	N.O.S.	150
MOT C100 DC REMOTE HANDSET W/ENCODER (T1474)	N.O.S.	350
CELLWAVE DUAL ISOLATOR W/100W HEAT SINK		125
MAXRAD 900MHZ 3DB BASE ANTENNA (MFB8963)	N.O.S.	50

SAVE THIS AD

MOTOROLA RECONDITIONED

"Maratrac"
(A2 HEAD)
$450
150 MHz
100W, 16Ch
w/accessories

"GR500"
Wall Mount
Repeater
w/ ac Power
w/o Duplexer
or radios
$500

NEW* MAXON CLOSE OUT
4150L*
136-150 Mhz
40w-16CH
w/Accessories
$200

*Discontinued w/2yr Factory Warranty

NEW* "ZPC" Series

Motorola "P1225"
150-174 MHz
450-470 MHz
5W/4W
2CH or 16CH
CALL OR FAX FOR PRICES
w/ accessories
*DISCONTINUED
w/ factory warranty

NEW*

Motorola "GP300"
465-495 MHz
4W 16 CH
w/accessories
CALL OR FAX FOR PRICE
*DISCONTINUED
w/ factory warranty

NEW*

Motorola "P200"
30-36 MHz
6W 6CH
"MT1000"
36-42 MHz
6W 32CH
w/ accessories
CALL OR FAX
FOR PRICES
*DISCONTINUED
w/ factory warranty

NEW* **ERICSSON / GE-MAXON PORTABLE RADIOS** NEW*
NEW OLD STOCK (N.O.S)*

(MONOGRAM) E/GE MODEL	MAXON EQUIV	SEE NOTE	DESCRIPTION	UNIT PRICE
MGP148 (MHB3HP)	SP2550XM	#1,#3,	148-162MHz 5W 10F	$115
MGP160 (MHB3JP)	SP2550XH	#1,#3,	160-174MHz 5W 10F	$115
KRY101611/1 (MGAEIV)	SA1421	#3	Remote Speaker Mic	Qty(1-10):$15,(10+):$12
MHC2BP	SP5050HD	#2	30-35MHz 5W 6F C/SQ	$100
MHC2CP	SP5050HD	#2	35-42MHz 5W 6F C/SQ	$100
MHNC3R (349A9730P11)	CA3535	---	30-35, 36-42 MHz Antenna	$10

NOTES:
#1 Includes Radio, Ant, Belt Clip (w/o Battery, Charger)
#2 Includes Radio, Batt, Belt Clip, Wall Charger
#3 Speaker Mic, works w/Maxon SL70/SP2550 Radios

IWCE Special
1 Speaker-Mic
FREE w/ each "MPG" Sold

*Radios manufactured in 1996/97 for Ericsson/GE by Maxon on an OEM basis. They are sold as new, but without Factory Warranty.

MOTOROLA "TS11"

The "SP10" Replacement
(for all dealer resale)
The Low Cost Alternative!
1watt VHF/UHF "PL" included

VHF: $132
UHF: $146

IWCE Special
Offer Expires
April 30, 2000

SAVE THIS AD

AIR COMM
TWO-WAY RADIO SALES
www.sales@air-comm.com

CALL/FAX FOR OTHER RADIOS & ACCESSORIES!
602-275-4505 • FAX:602-275-4555 • email: sacohen@primenet.com
WE STOCK "PL", PAGING REEDS AND CHANNEL ELEMENTS
4614 East McDowell Road
Phoenix, AZ 85008

SAVE THIS AD
Circle (114) on Fast Fact Card

trunking

tower space

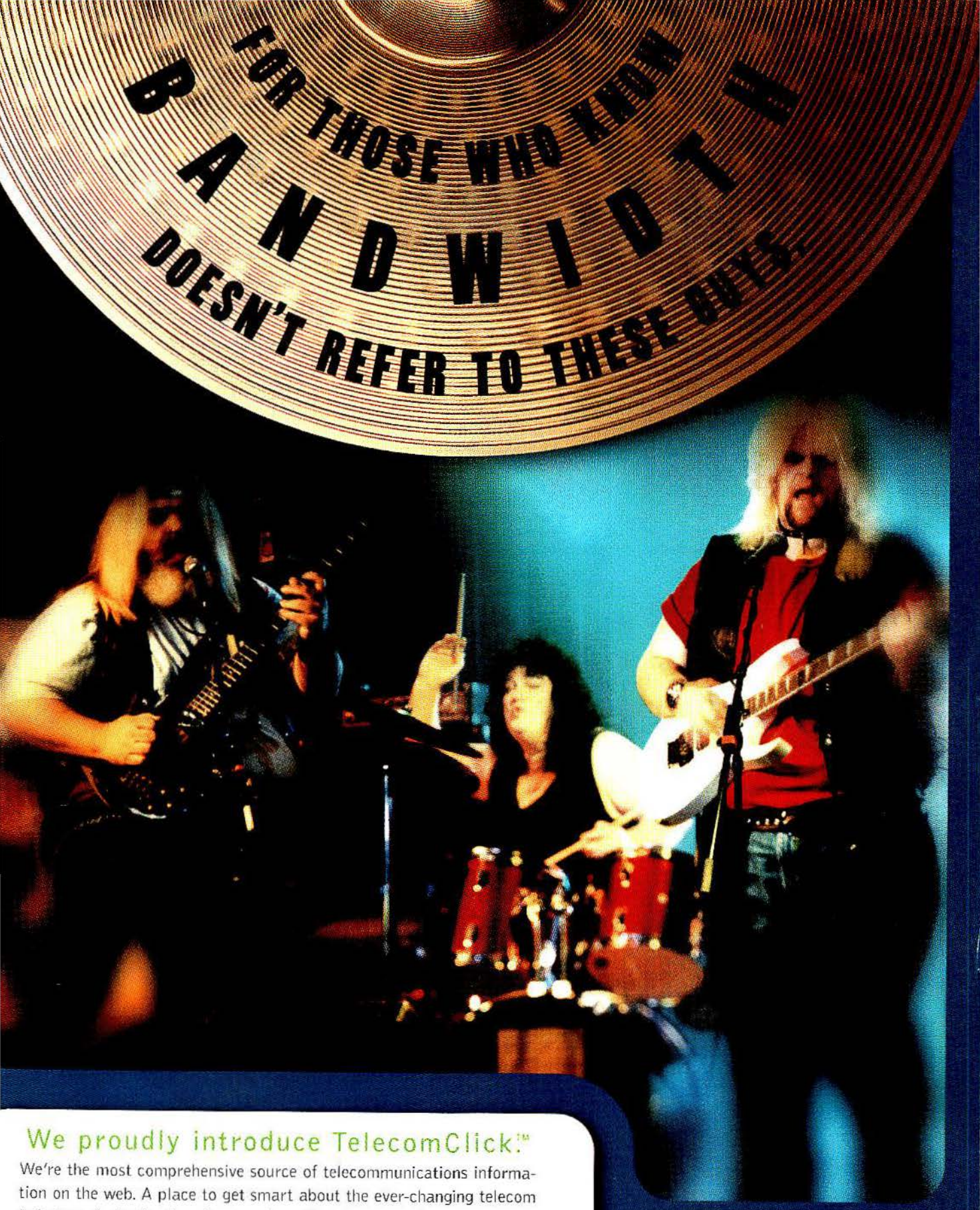
paging

repair services

repair services

AD INDEX

Company	Page Number	Fast Fact Number	Advertiser Hotline
Access	101	129	514-735-2424
Advanced Battery Systems, Inc.	44	36	800-634-8132
Advanced Charger Technology	56	47	770-582-0011
Advanced Receiver Research	85	78	860-485-0310
Advancetec Industries, Inc.	15	12	305-651-3211
AEA, A Div. of Tempo Research	42	34	760-598-8900
AeroComm, Inc.	59	50	201-227-0066
Air Comm	97	114	602-275-4505
Andrew Corp.	24	20	800-255-1479
Anritsu Company	13	11	800-ANR-ITSU
Anritsu Company	47	39	800-ANR-ITSU
Antenex	93	103	800-323-375
The Antenna Specialists Co. a division of Allen Telecom	34	28	440-349-8400
Applied Power Corp.	60	51	360-438-2110
Astron Corp	25	21	949-458-7277
Barnett Electronics Inc.	95	110	800-423-3858
Berkeley Varitronics	11	9	732-548-3737
Canamex Communications Corp.	64	57	800-387-4237
CeoTronics Inc.	63	56	972-416-9500
Champion Radio Products	67	60	888-833-3104
Charge Guard	32	26	800-458-3410
Charge Guard	79	72	800-458-3410
Citel America, Inc.	78	71	305-621-0022
David Clark Co., Inc.	30	24	508-751-5800
CommScope, Inc.	57	48	888-235-5732
Communications Specialists	BC	3	800-854-0547
Comnet-Ericsson	23	19	800-431-2345
Computer Resources Inc.	101	123	205-987-1523
Comtelco Industries Inc.	94	104	800-634-4622
Control Signal Corp.	76	70	800-521-2203
CPI Communications Inc.	68	62	800-869-9128
Crescend Technologies	65	58	800-872-6233
Diversified Electronics	72	65	404-361-4840
DLC	26	22	562-404-9998
Doppler Systems, Inc.	63	55	480-488-9755
Duracomm Corp.	86	83	800-467-6741
DX Radio	58	49	877-439-7234
Eartec/Porta Phone	75	68	800-399-5994
EDX Engineering, INc.	73	66	541-345-0019
E.F. Johnson	1	4	800-621-2945
Electrocom Communications	33	27	562-946-9493
EPCOM	96	112	915-533-5119
EML	96	111	615-771-2560
Fiplex Communications, Inc.	98	116	305-884-8991
The Genesis Group	103	128	903-561-6673
Gentex Corp.	65	59	800-258-3554
Globe Electric	94	105	281-933-0909
Hark Towers	99	120	843-764-1560
Henry Radio	16	14	800-877-7979
Holzberg Communications, Inc.	93	102	973-389-9600
ICOM America	35	29	425-454-8155
I-Com Industry, Inc.	86	82	703-707-9094
ICT	43	35	604-888-6304
IDA Corporation	82	75	701-280-1122
Industry Click	IBC	2	816-300-0323
I-Tech	39	31	619-458-1500
JEI Communications	80	73	530-677-3210
JFW Industries, Inc.	54	45	317-885-3247
JPS Communications	84	77	919-790-1011
Kenwood Communications	27	23	800-950-5005
Klein Electronics	98	115	760-631-2811
Leavitt Communications, Inc.	102	126	800-870-3686
Link Communications	62	53	406-587-4085
Maxrad, Inc.	81	74	800-323-9122
MCM Technology	89	85	205-655-8949
Mechem Electronics	94	102	540-891-0569
Modular Communication Systems	17	15	818-764-1333
Motorola Test Equipment	8a-b		800-422-4210
Motorola Test Equipment	9	8	800-422-4210
Narda/L3 Communications	6-7	7	516-231-1700
New Hampshire Communications	95	108	631-231-1700
Norcomm Corp.	74	67	800-874-8663
Novatel Wireless, Inc.	21	18	858-320-8800
Omnicron Electronics	62	54	860-928-0377
Otto Communications	83	76	847-428-7171
Paging & Wireless Service Center	67	61	800-822-2180
Penta Corporation	44	37	504-733-1700
Pipo Communications	92	101	323-466-5444
Polaris Industries	100	121	404-872-0722
Premier Communications	48	40	714-257-0300
Primus Electronics Corp	53	44	800-435-1636
ProComm	94	106	805-497-2397
PTI/Piezo Technology, Inc.	87	80	407-298-2000
Quantum Radionics	91	100	703-884-8548
Racal Communications, Inc.	55	46	301-948-4420
Radio Express, Inc.	95	109	703-631-1365
Radio Frequency Systems	41	33	203-630-3311
RCC Consultants	90	101	732-404-2400
RCW Distributing	99	119	612-808-0069
RF Imaging & Communications	98	117	925-229-2034
Ritron Inc.	51	43	800-USA-1USA
Sabre Communications	16	13	712-258-6690
Samlex America, Inc.	71	64	604-525-3836
Securicor Wireless	19	16	816-920-1128
Shure Brothers, Inc.	45	38	800-25S-HURE
Simulcast Solutions	95	107	716-223-4927
Sinclair Technologies Inc.	40	32	800-288-2763
Softwright	102	125	303-344-5486
Sonik	76	69	760-752-1011
Southwest Windpower	88	81	520-779-9463
Survey Technologies, Inc.	102	124	503-848-8500
TEKK, Inc.	89	84	816-746-1098
Telepath	96	113	510-656-5600
Telepoint Inc.	50	42	310-652-3666
Telewave, Inc.	61	52	800-331-3396
Thunder Eagle	68	63	888-877-8022
Times Microwave Systems	53	44	203-949-8400
Transcrypt International	31	25	800-894-2609
Transtector Systems	38	30	208-762-6055
Trident Micro Systems	20	17	800-798-7881
Trident Micro Systems	101	122	800-798-7881
TX RX Systems Inc.	3	5	716-549-4700
Vega/Telex Signaling Products	12	10	402-467-5321
VERTEX/YAESU USA	IFC	1	562-404-2700
WETEC	99	118	901-286-6275
W & W Manufacturing	5	6	800-221-0732
Zetron Inc.	49	41	425-820-6363
Z Technology	88	79	503-614-9800



We proudly introduce TelecomClick.™

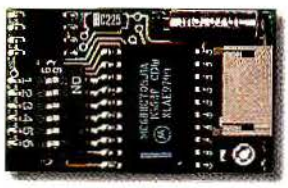
We're the most comprehensive source of telecommunications information on the web. A place to get smart about the ever-changing telecom industry. A destination for people with telecommunications on the brain. With TelecomClick, you get in-depth analysis and insight from the leading industry publications. And our nine channels dedicated to the global telecommunications market keep you abreast of the latest news and innovations. No matter what you're looking for in the telecommunications arena, you'll find it free of charge at TelecomClick. Go to www.telecomclick.com. Get connected.

TelecomClick

an IndustryClick community

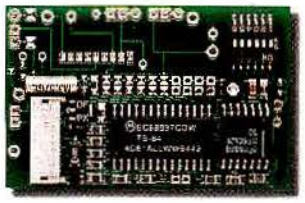
Circle (2) on Fast Fact Card

Where telecom clicks on the web



SS-64 $28.95
Microminiature DIP Switch Programmable CTCSS Encoder.
Includes 64 tones from 33.0 to 254.1 Hz.
.66" x 1.08" x .21"

TS-64 $54.95
Sub-miniature Programmable CTCSS Encoder-Decoder.
Includes 64 tones from 33.0 to 254.1 Hz.
.78" x 1.70" x .25"



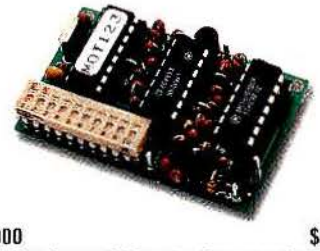
TS-64DS $57.95
DIP Switch Programmable CTCSS Encoder-Decoder.
Includes 64 tones from 33.0 to 254.1 Hz.
1.25" x 2.0" x .30"

ANI-1/$39.95 **ANI-2/$299.95**
Automatic Number Identification System
ANI-1 Encoder - 1.13" x .66" x .22"
ANI-2 Station Decoder - 5.4" x 5.8" x 1.4"

ID-8 $69.95
Automatic Morse Station Identifier. Meets all FCC ID Requirements. Fully field programmable with included keypad. 1.85" x 1.12" x .35"

TP-3200 $279.95
Full Featured Shared Repeater Tone Panel with ALL 157 CTCSS/DCS codes. In Desktop or Rack Mount versions.

PE-1000 $224.95
Desktop Paging Encoder. Two-Tone Sequential, other formats available. 7.5" x 7.6" x 2.7"



SD-1000 $59.95
Two-Tone Sequential Decoder. Programmable unit provides switched outputs from Two-Tone paging calls.
1.25" x 2.0" x .4"

PE-2P $54.95
Two-Tone Sequential Encoder. Sub-assembly mounts inside radio or other enclosure. Multiple call capability.
1.25" x 2.0" x .4"

DCS-23 $59.95
Digital Coded Squelch Encoder-Decoder. Programmable to all 106 DCS codes. 1.36" x 1.18" x .25"

TE-64D $129.90
Multi-Purpose CTCSS/Burst Tone Encoder w/LED Display. Great for the Benchtop. 5.25" x 3.3" x 1.7"

FILTERS
Call us for the lowest cost, 12.5kHz channel spacing, exact replacement, crystal and ceramic IF filters for Part 90 Refarming.

See our complete catalog and product descriptions on our web site at

www.com-spec.com

Circle (3) on Fast Fact Card

- **Same reliable and cost effective products you have known and trusted for 30 years!**
- **Full FIVE YEAR WARRANTY on all products**
- **"INFO FAX" with 24 hour information**
- **Same day shipping on most orders**
- **Toll free 800 numbers for both voice and FAX**

COMMUNICATIONS SPECIALISTS, INC.
426 WEST TAFT AVENUE • ORANGE, CA 92865-4296
(714) 998-3021 • FAX (714) 974-3420
ENTIRE U.S.A. (800) 854-0547 •FAX (800) 850-0547

Outside USA or Canada Cessna International, 90 17th Avenue, San Mateo, CA 94402 USA • Phone (650) 574-1491 • FAX (650) 574-5797